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July 1971

THE VARIATION OF SHOCK FRONT PROPERTIES FROM A 1-KT. EXPLOSION WITH ALTITUDE

Edward J. Kownacki

HEADQUARTERS
Defense Nuclear Agency
Washington, D.C. 20305

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ABSTRACT

A computer program was developed to present shock front properties in the form of isovalues as functions of altitude of burst and range. This program consisted of a Sachs' scaling routine and a log-log interpolation routine. It was found that overpressure, density, and Rho-U decrease with increasing altitude; particle velocity, density ratio, pressure ratio, and shock strength increase with increasing altitude; thermal flux density and dynamic pressure remain relatively unchanged with increasing altitude.

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SECTION 1

INTRODUCTION

The standard scientific presentation of weapons effects information is in the form of universal curves as in NOLTR-69-88[1] and EM-1.[2] For engineering purposes a presentation in the form of isovalues in the desired quantities on a chart of altitude and damage ranges may provide a more significant insight into the altitude dependence of isovalue ranges. The obtaining of these preselected isovalues is a standard and somewhat tedious problem in cross plotting and interpolation. Sachs' scaling and interpolation computer routines were obtained from NOL[3] and modified to incorporate logarithmic interpolation.

---

[1] Lehto, D. L., and Larson, R. A. "Long Range Propagation of Spherical Shock Waves from Explosions in Air." NOLTR-69-88. (Unclassified)

[2] "Capabilities of Nuclear Weapons." EM-1. (Confidential)

[3] Lehto, D. L., various private communications on computer programs for Sachs' scaling and interpolation schemes.

SECTION 2

DISCUSSION

2-1. GENERAL. Damage to aeronautical and missile systems within the sensible atmosphere (0 to 100,000 feet altitude) from nuclear weapons effects is expressible in terms of damage distances for damage environments, such as overpressure, dynamic pressure, thermal radiation, neutron and X-ray flux, etc. For some systems the dominant or largest damage distances are associated with hydrodynamic shock front properties or thermal radiation. These systems are generally aerodynamic vehicles, such as aircraft, cruise missiles, and low-altitude-point defense missiles, such as the 3T's, Nike, or Sprint.

2-2. SHOCK FRONT PROPERTIES. The hydrodynamic shock front properties of interest to aerodynamic vehicles can be defined by a system consisting of a sea-level, 1-kt. pressure-distance curve and a means of obtaining altitude and yield corrections to this basic curve.

2-3. THERMAL FLUX DENSITY. The thermal flux density (Q) is defined by the formula $Q = fWc/R^2$, where R is the range, f is the thermal partition function, W is the yield, and c is a constant containing dimension factors and the transparency factor (T) of the atmosphere (in our case T = 1, perfect transparency).

2-4. STANDARD 1-KT. NUCLEAR FREE AIR PRESSURE-DISTANCE CURVE FOR SEA-LEVEL CONDITIONS. The data for the 1 kt., sea-level overpressure curve was provided by two sources:

above 60 p.s.i., US59 (DASA 1200)
below 60 p.s.i., NOLTR 69-88.

This data is listed as Subroutine RP1271 and plotted in figure 2-1.

2-5. STANDARD 1-KT. NUCLEAR THERMAL FLUX-DISTANCE CURVE FOR SEA-LEVEL CONDITIONS. The thermal flux density formula used was $Q = 7.96\ fW/R^2$, where 7.96 includes the transparency factor (1), the dimensionless factor $\frac{1}{4\pi}$, and the unit factor to give Q in terms of cal./cm.^{2}. The sea-level, 1-kt. thermal flux density is found plotted in figure 2-2.

2-6. ALTITUDE CORRECTIONS-SACHS' SCALING. The altitude corrections applied are the usual Sachs' scaling relationships:

$$\frac{\Delta P_1}{P_1} = \frac{\Delta P_2}{P_2}$$

When:

$$R_1 \left[\frac{P_1}{W_1}\right]^{1/3} = R_2 \left[\frac{P_2}{W_2}\right]^{1/3}$$

Where:

ΔP_1 and ΔP_2 are overpressures for point 1 and point 2, respectively, P_1 and P_2 are the respective atmospheric pressures, R_1 and R_2 are the respective ranges, and W_1 and W_2 are the respective yields.

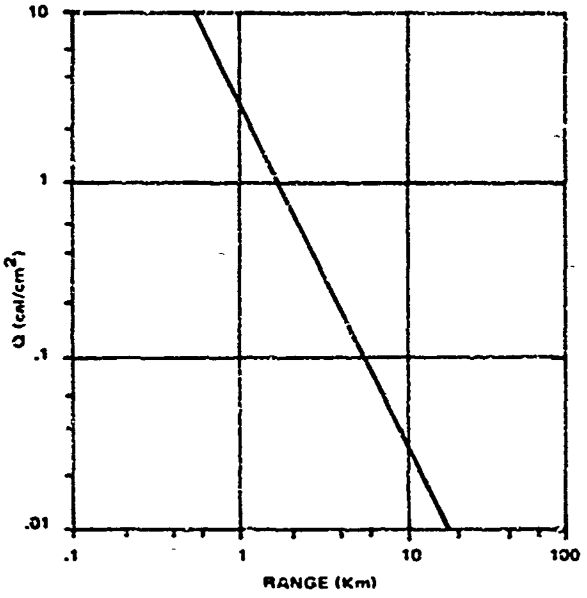


Figure 2-1. --1-kt., sea-level overpressure curve in the range 1,700 to 0.00026 p.s.i.

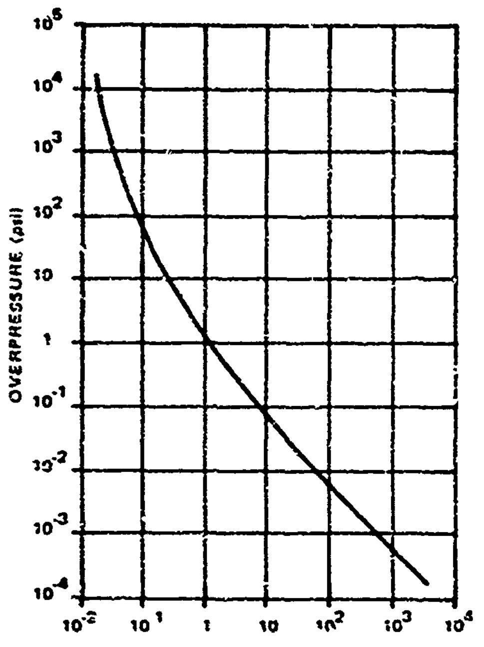


Figure 2-2. --1-kt. thermal flux curve for sea-level conditions.

2-6.1 Subroutine ARDC provides pressure, temperature, and density of the standard atmosphere. The data was provided by R. A. Minzer, K. S. W. Champion, and H. L. Pond in "The ARDC Model Atmosphere," 1959, Air Forces Surveys in Geophysics No. 115 (AFCRC-TR-59-267), Air Force Cambridge Research Center, August 1959.

2-6.2 Using the overpressure-range curve of Subroutine RP1271 as the base curve, and the atmospheric pressures generated by subroutine ARDC, the overpressures for any altitude and any corrected yield (in this exercise $W_1 = W_2$) can be calculated.

2-7. ENERGY PARTITION FOR BLAST AND THERMAL AS A FUNCTION OF ALTITUDE. The yield corrections which are applied are obtained from the more formally correct radiation-hydrodynamic computer code calculations. These corrections are, unfortunately, functions of yield, distance, and altitude; but, for the range of hydrodynamic front and thermal radiation variables of interest in this memorandum, the yield correction is assumed to be a simple function of altitude only. The simplifications used in this memorandum are straight-line approximations to the curves presented in EM-1, and are applied first to the overpressure dependent qualities, and then independently to the thermal radiation.

2-7.1 The blast yield reduction with altitude function was taken from the effects manual, "Capabilities of Nuclear Weapons," 1 January 1968, and the thermal partition function was taken from chapter 3, "Thermal Radiation Phenomena," KN-68-504(R), 26 May 1969. These two functions are found plotted as figures 2-3 and 2-4. Also plotted are the straight-line approximations which were used in the computer program.

2-7.2 These straight-line approximations were used mainly for the purpose of facilitating computer time. There is no simple functional dependence between altitude and the quantities, and so to avoid feeding in all the data points for every possible altitude, the straight-line approximation was adopted.

2-7.3 For the blast yield reduction curve, the greatest difference occurs around 80 kft., where there is a difference of 0.02 (approximately 2-percent error) between the curve and the approximation. The curve and the approximation agree quite well over the whole altitude range, the error being less than 1 percent over most of the range.

2-7.4 The blast yield reduction curve can be compared with a plot of the maximum computed effective blast yield in DASA 1290. This plot is shown in figure 2-5. The straight-line approximation used in the program was fitted to the curve, not to the envelope of figure 2-5, because in the altitude range of interest there are only two computations (at 105 kft.), and the curve intersects these points while the envelope does not. The function used is considered conservative for defense purposes, as in sure-survival studies on aircraft.

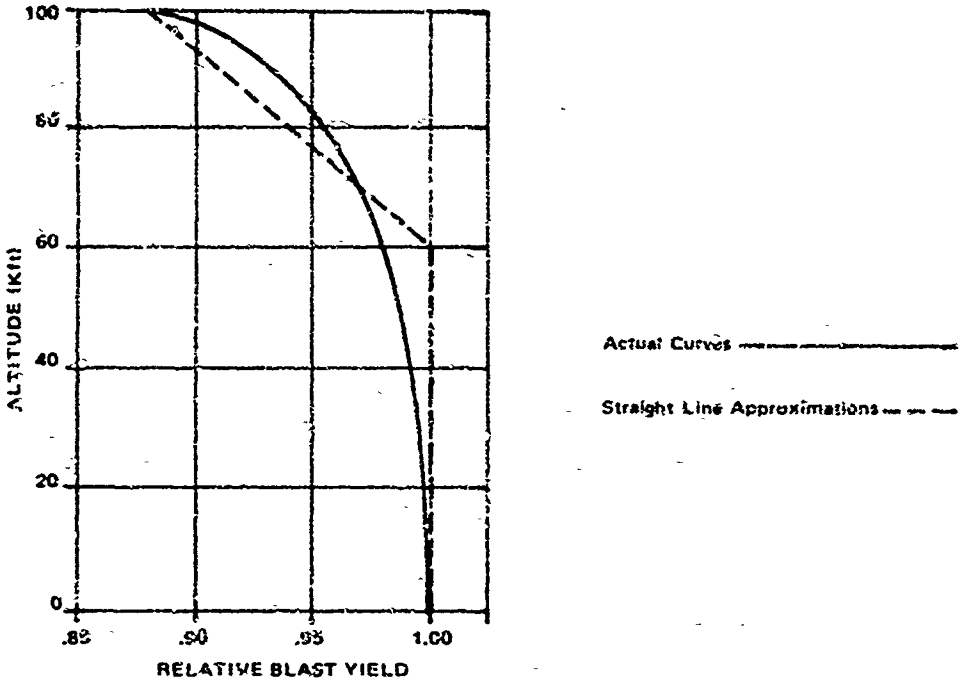


Figure 2-3. --Blast yield reduction with altitude.

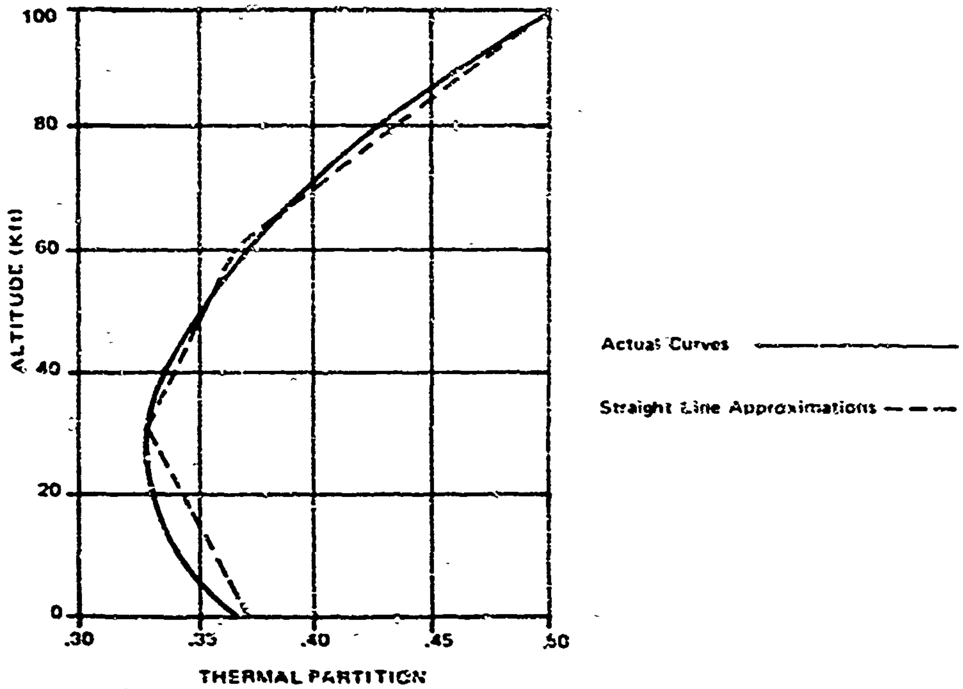


Figure 2-4. —Thermal partition function for 1 kt.

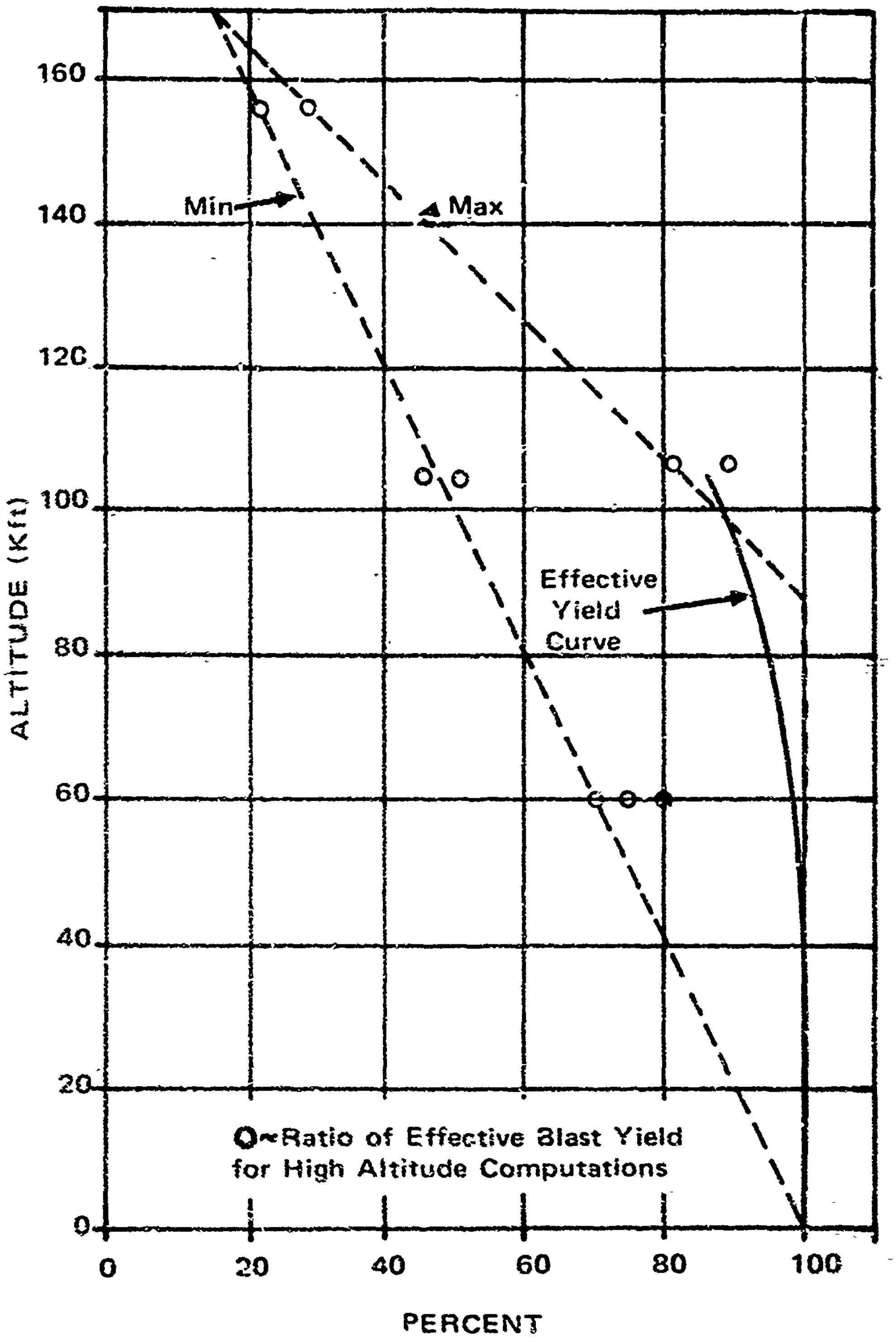


Figure 2-5. --Effective blast yield versus burst altitude.

2-7.5 For the thermal partition function, the greatest difference occurs around 20 kft., where there is a difference of 0.01 (approximately 2-percent error) between the curve and the approximation. For the majority of altitudes, the error is less than 1 percent.

2-8. PRESENTATION OF SHOCK FRONT PROPERTIES (RANKINE-HUGONIOT RELATIONS) VERSUS ALTITUDE CURVES AND THERMAL FLUX DENSITY VERSUS ALTITUDE CURVES.

The Rankine-Hugoniot relations[4] enable the calculation of density, density ratio, particle velocity, pressure ratio, shock strength, and dynamic pressure behind the shock front if the peak overpressure is given.

2-8.1 The program presented is not the most efficient program because a slight rearrangement of cards is necessary when changing from interpolation of one quantity to another (i.e., overpressure to dynamic pressure, density to thermal flux density, etc.). The card rearrangement is simple and straighforward and preferable to one gigantic, complex program that would just be nine programs added together. This simple card rearrangement can be seen in the sample programs presented in appendix II.

2-8.2 The peak overpressure isovalues are presented in figure 2-6, the dynamic pressure isovalues in figure 2-7, the particle velocity in figure 2-8, the density ratio in figure 2-9, the particle velocity × density (Rho-U) in figure 2-10, the pressure ratio in figure 2-11, the shock strength in figure 2-12, and the density in figure 2-13.

2-8.3 All quantities were plotted from sea level to 100-kft. altitude, except for density, which is plotted only from sea level to 40 kft. in the most advantageous cases. The reason for this can be discerned by doing a few simple calculations.

2-8.4 The formula for density is $\text{DENSITY} = 0.0764575 \times \text{DRATIO} \times \frac{7 + 6\ \text{POVPA}}{7 + \text{POVPA}}$ where $\text{POVPA} = \frac{\text{OVP}}{\text{PSIAMB}}$. Since DRATIO = 1 at sea level, the minimum and maximum values of DENSITY are entirely dependent on the theoretical limits of OVP.

$$\begin{aligned}\text{If OVP} = 0,\ \text{DENSITY} &= 0.076475\\ \text{If OVP} \rightarrow \infty,\ \text{DENSITY} &= 0.076475 \times 6 = 0.45885\\ \text{At 50 kft., DRATIO} &= \frac{0.011709}{0.076475}.\end{aligned}$$

Therefore, if $\text{OVP} \rightarrow \infty$, $\text{DENSITY} = 0.076475 \times \frac{0.011709}{0.076475} \times 6 = 0.070254$.

2-8.5 Since the highest possible value of DENSITY at 50 kft. is less than the lowest possible value of DENSITY at sea level, it is impossible to produce a plot that will have an altitude dependence from sea level to greater than 40 kft.

2-8.6 The thermal flux density isovalues are presented in figure 2-14.

---

[4] Glasstone, S. (ed.). "The Effects of Nuclear Weapons." 1964.

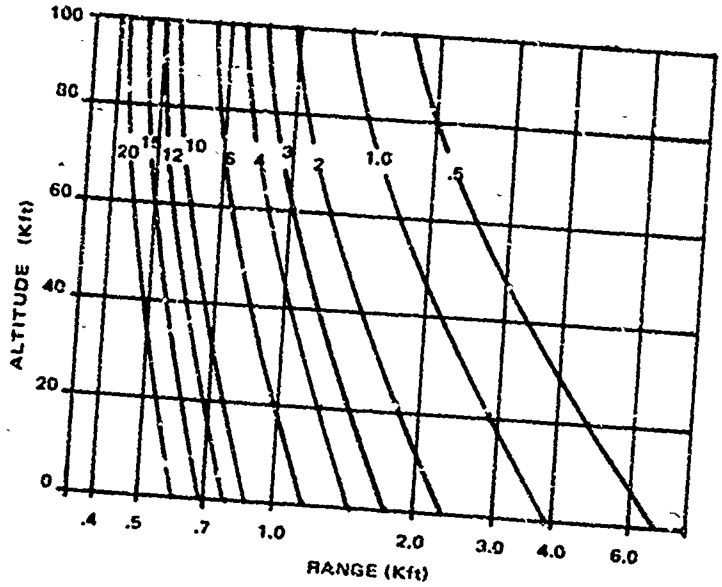


Figure 2-6. -- Free-field overpressure (p. s. i.) as a function of altitude and range.

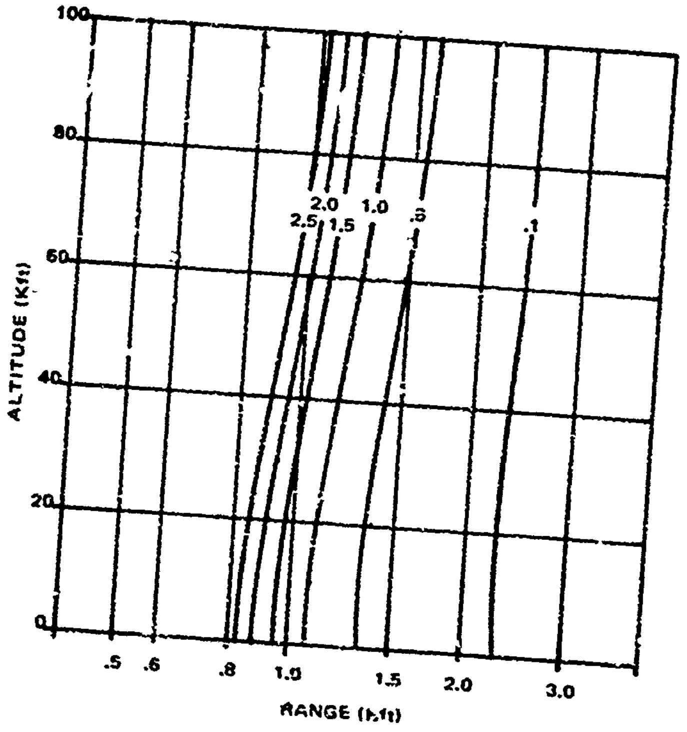


Figure 2-7. --Dynamic pressure (p. s. i.) as a function of altitude and range.

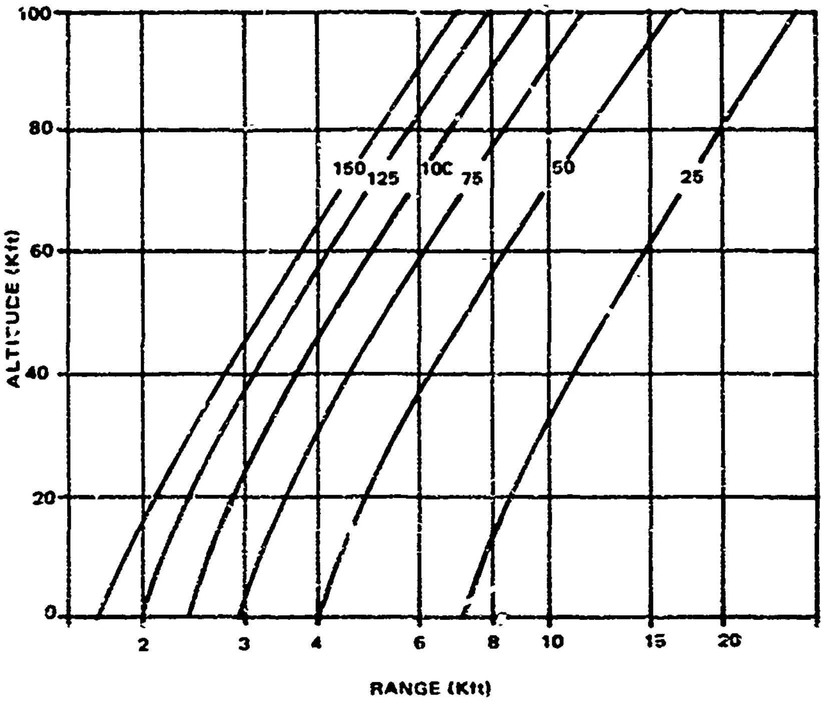


Figure 2-8. --Particle velocity (ft. /sec.) as a function of altitude and range.

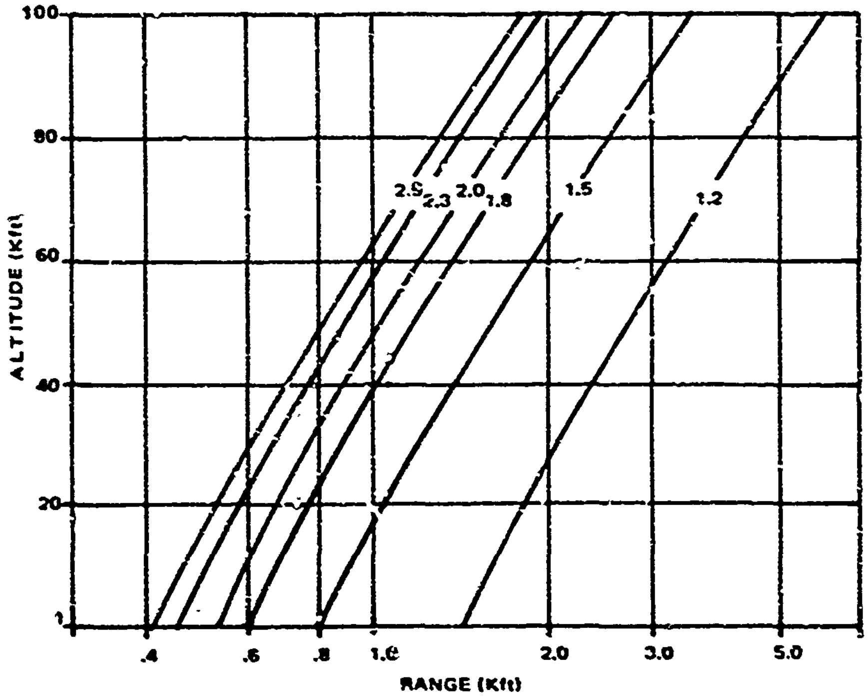


Figure 2-9. --Density ratio as a function of altitude and range.

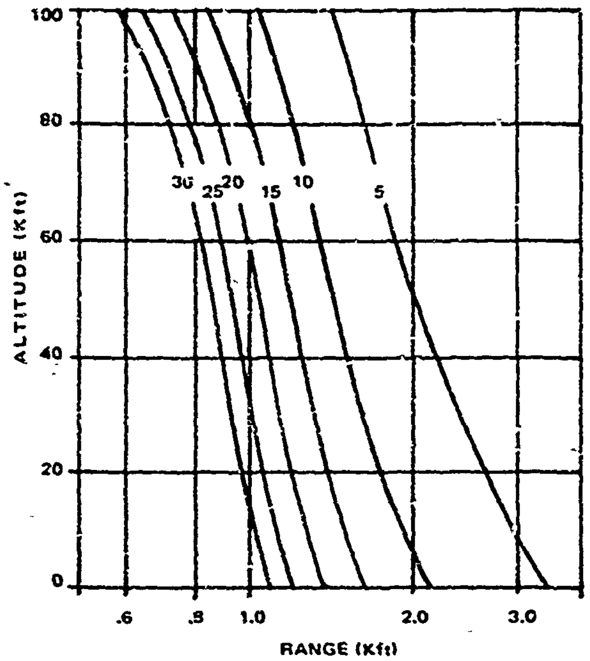
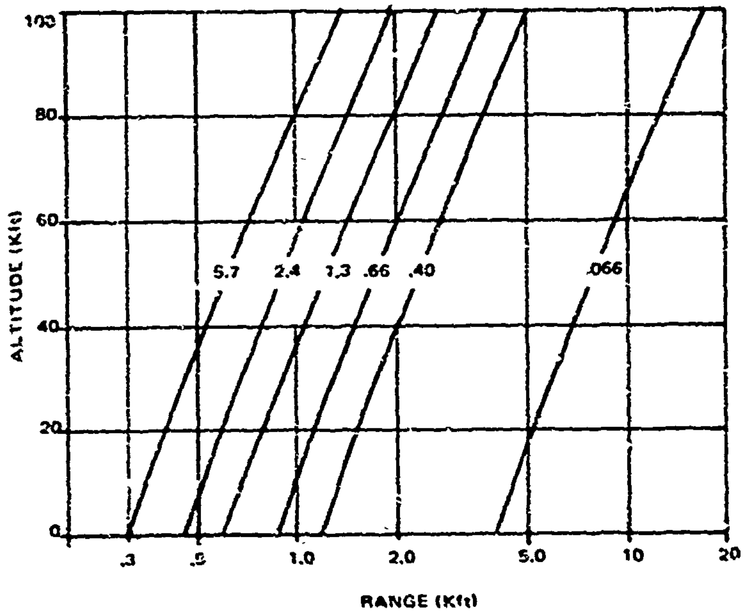


Figure 2-10. --Rho-U (slugs/(in.^{2}-sec.)) as a function of altitude and range.

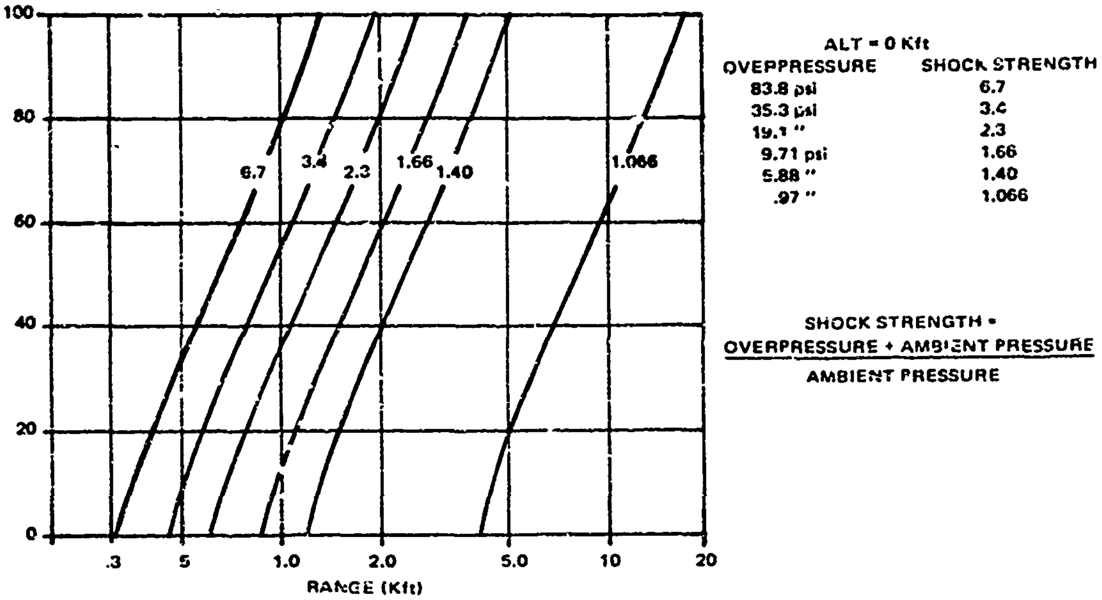


ALT = 0 KFT

OVERPRESSURE	PRESSURE RATIO
83.8 psi	5.7
35.3 "	2.4
19.1 "	1.3
9.71 psi	.66
5.88 "	.40
.97 "	.066

$$\text{Pressure Ratio} = \frac{\text{Overpressure}}{\text{Ambient Pressure}}$$

Figure 2-11. --Pressure ratio as a function of altitude and range.



ALT = 0 Kft

OVERPRESSURE	SHOCK STRENGTH
83.8 psi	6.7
35.3 psi	3.4
19.1 "	2.3
9.71 psi	1.66
5.88 "	1.40
.97 "	1.066

$$\text{SHOCK STRENGTH} = \frac{\text{OVERPRESSURE} + \text{AMBIENT PRESSURE}}{\text{AMBIENT PRESSURE}}$$

Figure 2-12. --Shock strength as a function of altitude and range.

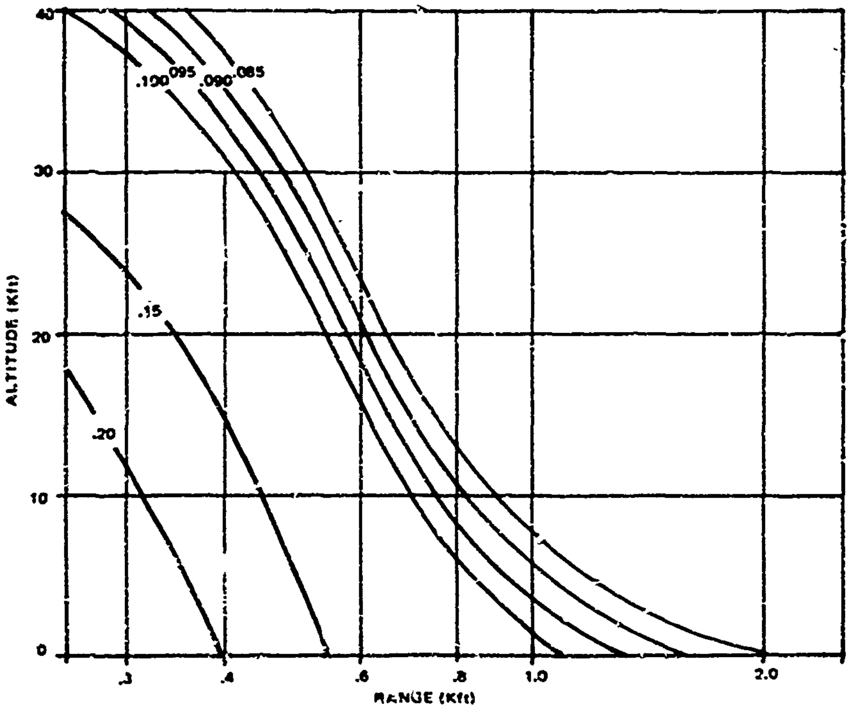


Figure 2-13. --Density (slugs/(ft. - in.^{2})) as a function of altitude and range.

2-9. **YIELD CORRECTIONS.** Distance approximations for values of yield other than those presented in this memorandum may be obtained by multiplying the range by the cube root of the yield for hydrodynamic properties and the square root of the yield for thermal radiation. Discrepancies in the yield-correction factors are masked somewhat by the cube root and square root dependence, but very large yield variations may require more accurate estimates of the yield-corrections factor as presented in EM-1.

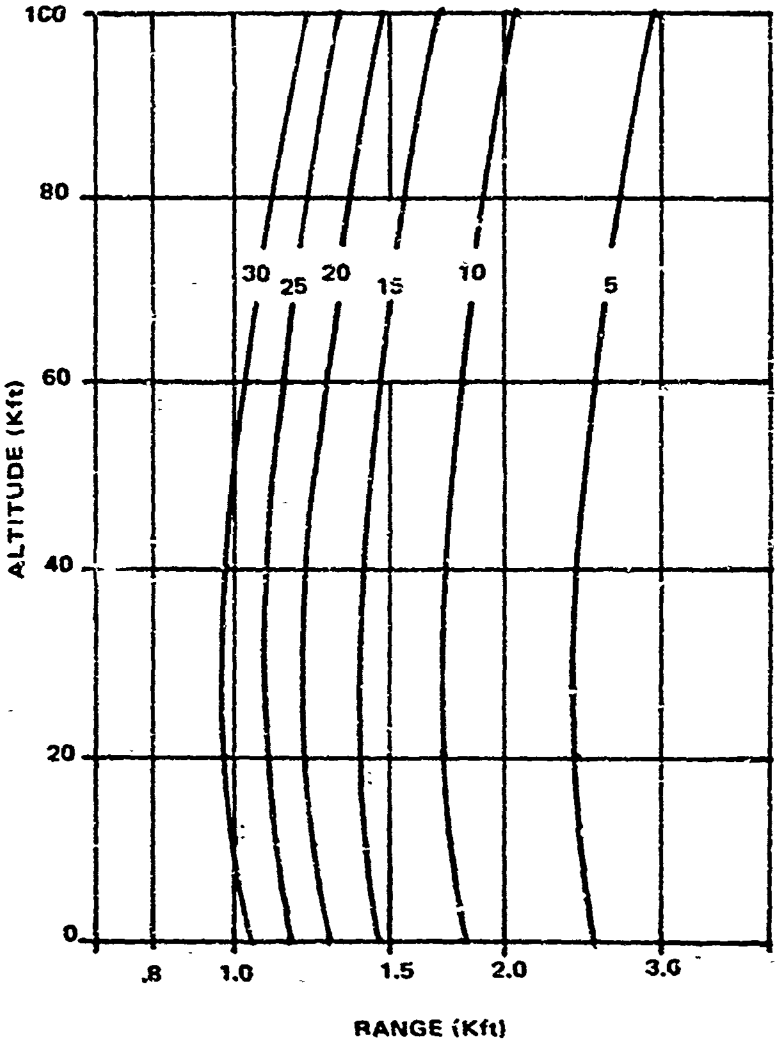


Figure 2-14.--Thermal flux density (cal./cm.^{2}) as a function of altitude and range.

SECTION 3

CONCLUSIONS

3-1. It is found that overpressure, density, and Rho-U decrease with increasing altitude; particle velocity, pressure ratio, shock strength, and density ratio increase with increasing altitude; thermal flux density and dynamic pressure remain relatively unchanged with increasing altitude.

3-2. This type of presentation should be very useful in determining approximate sure-kill and/or sure-survival ranges for the various aerodynamic vehicles. By placing the various isovalues on a single chart, a sure-kill envelope could be drawn for the range 0 to 100,000 feet. For example, if the sure-kill criteria is an overpressure of 2 p.s.i., a particle velocity of 100 ft./sec., or a thermal flux density of 20 cal./cm.^{2}, and a sure-survival criteria is an overpressure of 1 p.s.i., a particle velocity of 50 ft./sec., or a thermal flux density of 10 cal./cm.^{2}, then the determining sure-kill/sure-survival range for a 1-kt. explosion is entirely dependent on the particle velocity, as shown in figure 3-1.

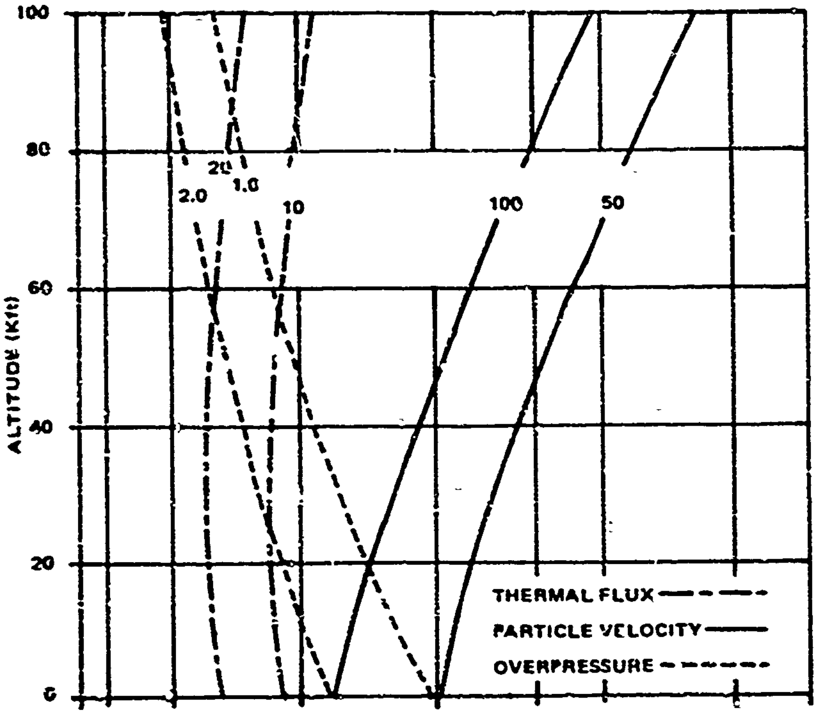


Figure 3-1. --Free-field overpressure (p.s.i.), thermal flux density (cal./cm.^{2}), and particle velocity (ft./sec.) for 1 kt.

SECTION 4

BIBLIOGRAPHY

1. "Nuclear Weapons Blast Phenomena." US59 (DASA 1200), March 1960.

2. "Long Range Propagation of Spherical Shockwaves from Explosions in Air." NOLTR 69-88, 22 July 1969.

3. Effects manual, "Capabilities of Nuclear Weapons." 1 January 1968.

4. "Thermal Radiation Phenomena." KN-68-504(R), Chapter 3, 26 May 1969.

5. "The ARDC Model Atmosphere." Air Force Surveys in Geophysics No. 115 (AFCRC-TR-59-267), 1959.

APPENDIX I

INTERPOLATION SCHEME

The interpolation scheme used is a straight-line approximation scheme; i.e., it is assumed that in a well-behaved region of a curve, two points can be chosen, and the straight line defined by these points can be used to generate a value of R that will approach the desired value of R. By repeated use of this scheme, the desired value of R can be approached to within any desired accuracy. The program actually used an accuracy of 0.1 percent in R.

An initial value of R_1 is chosen, and then R_2 is chosen to be equal to $2R_1$. The scheme is as follows:

$$\text{slope} = \frac{f(R_1) - f(R_2)}{R_1 - R_2}$$

$$\text{obviously, slope} = \frac{f(R_1) - f\left(R_{\text{desired}}\right)}{R_1 - R_{\text{new}}}$$

$$\text{therefore, } R_{\text{new}} = \frac{R_1 + f\left(R_{\text{desired}}\right) - f(R_1)}{\text{slope}} .$$

If $|R_{\text{new}} - R_1| \leq 0.001R_1$, then R_{new} is indeed R_{desired}. If $|R_{\text{new}} - R_1| > 0.001R_1$, then

$$R_1 = R_2$$

$$R_2 = R_{\text{new}}$$

and another value of R is generated until the condition of $|R_{\text{new}} - R_1| \leq 0.001R_1$ is met.

This method of interpolation is valid as long as the following conditions are met:

(1) $f(R_1) = f(R_2)$ for $R_1 = R_2$

(2) $f(R)$ is continuous over the specified range

(3) $f'(R)$ is continuous over the specified range.

Obviously, the closer f (R) is to a straight line, the faster this scheme will work. For this reason, since the base curve overpressure plot, which is the main curve for calculating most of our quantities, has a dependence on R similar to $R^{-\text{exponent}}$, and $Q \propto R^{-2}$, a log-log plot was used; that is, instead of slope $= \frac{f(R_1) - f(R_2)}{R_1 - R_2}$, the formula slope =

$$\frac{\log f(R_1) - \log f(R_2)}{\log R_1 - \log R_2} \text{ was used.}$$

The use of this latter formula is more than just a convenience, it is a necessity when R approaches 0. At this point (R = 0), the necessary conditions that f(R) and f′(R) be continuous no

longer hold. By "flattening" the curve with the use of log f(R), the discontinuity at R = 0 can be much more closely approached.

APPENDIX II

FORTRAN PROGRAMS AND PRINTOUTS

A. SUBROUTINE RP 1271

```
      SUBROUTINE RP1271(RKM,PSI)                                          C
C     SUBROUTINE FOR 1KT/SL BASE CURVE.  RETURNS OVERPRESSURE(PSI) WHEN   C
C     GIVEN RANGE RKM(KM).                                                C
C     SOURCES OF DATA--ABOVE 60 PSI, US59.  BELOW 60, NOLTR 69-88.        C
      DIMENSION R(74),P(74)                                               C
      DATA NLIST/74/                                                      C
      DATA R/.01524,.01905,.02286,.02667,.03048,.03810,.04572,.05334,     C
     1.06096,.06858,.07620,.08382,.09144,.09906,.10668,                   C
     1                             .1143,.1295,.1448,.1616,.1778,         C
     2 .184, .194, .223, .243, .265, .284, .307, .328, .370, .411,        C
     3 .442, .489, .530, .562, .603, .655, .731, .834, .927, 1.0 ,        C
     4 1.09, 1.18,1.255, 1.35, 1.52, 1.69, 1.85, 2.18, 2.51, 3.17,        C
     5 3.82, 4.48, 5.14, 5.79, 7.10, 8.41, 9.74,11.03,12.33,14.34,        C
     617.55, 20.2, 22.8, 25.4, 28.7, 34.5, 41.7, 57.4, 78.2, 120.,        C
     7 193., 318., 694., 2865./                                           C
      DATA P/17200., 8000., 4240., 2490., 1640.,  900.,  545.,  360.,     C
     1 246., 186., 144., 107., 88.8, 73.9, 62.7,                          C
     1                         50.02,40.97,34.22,29.09,21.93,             C
     219.38,17.28,13.54,11.38,9.743,8.474,7.446,6.054,5.026,4.548,        C
     34.074,3.533,3.108,2.769,2.491,2.065,1.899,1.584,1.390,1.235,        C
     41.116,1.007,.9232,.8366,.7383,.6377,.5663,.4608,.3873,.3017,        C
     5.2326,.1927,.1641,.1426,.1125,.0926,.0784,.0679,.0598,.0481,        C
     6.03015,.03438,.0313,.02658,.02318,.01844,.01536,.01376,.00744,.00481C
     7,.002880,.001688,7.337E-4,1.639E-4/                                 C
C                                                                         C
      DO 10 N=1,NLIST                                                     C
      IF(RKM.LT.R(N)) GO TO 11                                            C
   10 CONTINUE                                                            C
      GO TO 98                                                            C
   11 IF(N.EQ.1) GO TO 98                                                 C
      FACT=(ALOG10(RKM)-ALOG10(R(N-1)))/(ALOG10(R(N))-ALOG10(R(N-1)))     C
      PSILOG=ALOG10(P(N-1)) +FACT*(ALOG10(P(N))-ALOG10(P(N-1)))           C
      PSI=10.**PSILOG                                                     C
      RETURN                                                              C
   98 PSI=0.                                                              C
      RETURN                                                              C
      END                                                                 C

01/19/72     4:05 PM    ASR84.5    11073     COMPILER
  0 MIN  9 SEC FOR COMPILATION PASS
   38 CARDS AT 233 CARDS PER MINUTE
  1922 DIGITS DATA,  1278 DIGITS CODE.
```

B. SUBROUTINE ARDC

```
      SUBROUTINE ARDC(ALTCM,PRATIO,TRATIO,DRATIO)                  ARDC    C
C     REFERENCE                                                            C
C          R.A.MINZNER,K.S.W.CHAMPION, AND R.L.POND, THE ARDC MODEL        C
C          ATMOSPHERE, 1959, AIR FORCE SURVEYS IN GEOPHYSICS NO. 115       C
C          (AFCRC-TR-59-267), AIR FORCE CAMBRIDGE RES. CENTER, AUG 1959.   C
C     ALTCM=ALTITUDE IN CENTIMETERS                                        C
C     PRATIO=RATIO OF AMBIENT PRESSURE TO SEA LEVEL PRESSURE (1 ATM),      C
C     TRATIO=RATIO OF AMBIENT TEMPERATURE TO SEA LEVEL TEMP (288.16 K),    C
C     DRATIO=RATIO OF AMBIENT DENSITY TO SEA LEVEL DENSITY(.001225 G/CC)   C
C                                                                          C
  100 ALTZ=ALTCM/100.                                                      C
      ALTM=6356766.0*ALTZ/(6356766.0+ALTZ)                                 C
      IF(ALTM.GT.11000.) GO TO 102                                         C
  101 TEMP=288.16-0.0065*ALTM                                              C
      PAMB=14.696173/(288.160/(288.140-0.0065*ALTM))**5.25612210           C

      GO TO 118                                                            C
  102 IF(ALTM.GT.25000.) GO TO 104                                         C
  103 TEMP=216.66                                                          C
      PAMB=3.282545297/(10.**(0.068483253E-3*(ALTM-11000.0)))              C

      GO TO 118                                                            C
  104 IF(ALTM.GT.47000.) GO TO 106                                         C
  105 TEMP=216.66+0.003*(ALTM-25000.0)                                     C
      PAMB=0.36094654/(((141.660+3.0E-3*ALTM)/216.66)**11.38825473         C

      GO TO 118                                                            C
  106 IF(ALTM.GT.53000.) GO TO 108                                         C
  107 TEMP=282.66                                                          C
      PAMB=0.01745887/(10.**(0.0524926823E-3*(ALTM-47000.0)))              C

      GO TO 118                                                            C
  108 IF(ALTM.GT.79000.) GO TO 110                                         C
  109 TEMP=282.66-0.0045*(ALTM-53000.0)                                    C
      PAMB=8.40408E-3/((282.66/TEMP)**7.592176)                            C
      GO TO 118                                                            C
  110 IF(ALTM.GT.90000.) GO TO 112                                         C
  111 TEMP=165.66                                                          C
      PAMB=1.46198E-4*EXP (-0.0341647982*(ALTM-79000.0)/165.66)       F    C

      GO TO 118                                                            C
  112 IF(ALTM.GT.105000.) GO TO 114                                        C
  113 TEMP=165.66+0.0040*(ALTM-90000.0)                                    C
      PAMB=1.5519E-5*(165.66/TEMP)**8.541198                               C
      GO TO 118                                                            C
  114 IF(ALTM.GT.160000.) GO TO 116                                        C
  115 TEMP=225.66+0.02*(ALTM-105000.0)                                     C
      PAMB=1.34482E-6*(225.66/TEMP)**1.709239                              C
      GO TO 118                                                            C

  116 IF(ALTM.GT.170000.) GO TO 119                                        C
  117 TEMP=1325.66+0.010*(ALTM-160000.0)                                   C
      PAMB=5.14015E-9*(1325.66/TEMP)**3.4164798                            C
      GO TO 118                                                            C
  119 IF(ALTM.GT.200000.) GO TO 121                                        C
  120 TEMP=1425.66+0.005*(ALTM-170000.0)                                   C
      PAMB=4.6854E-9*(1425.66/TEMP)**6.832958                              C
      GO TO 118                                                            C
  121 TEMP=1575.66+0.0035*(ALTM-200000.0)                                  C
      PAMB=2.0593E-9*(1575.66/TEMP)**9.751369                              C
  118 TRATIO=TEMP/288.16                                                   C
      PRATIO=PAMB/14.696178                                                C
      DENSAM=3.2365427E-4*PAMB/TEMP                                        C
C     DENSAM IS IN UNITS OF SLUGS PER SQUARE INCH PER FOOT.                C
      DRATIO=DENSAM/.0000165                                               C
      RETURN                                                               C
      END                                                                . C

01/21/72     1:46 PM   ASN69.5   -12172    COMPILER
  3 MIN 19 SEC FOR COMPILATION PASS
  65 CARDS AT 196 CARDS PER MINUTE
  824 DIGITS DATA.  3106 DIGITS CODE.
```

C. PEAK OVERPRESSURE PROGRAM

```
0001
FILE 5=HOBBAX, UNIT = READER
      DIMENSION HOBKM(11),VAL(11)
    1 READ(5,2) W,COST,R,IM,IVAL
    2 FORMAT(3E10.3,2I10)
      READ(5,3) (HOBKM(I),I=1,IM)
    3 FORMAT(8E10.3)
      READ(5,3) (VAL(I),I=1,IVAL)
      CALL CLOSE(5,LOCK)
      WRITE(6,4)
    4 FORMAT(30H    W       COST       RMIN  )
      WRITE(6,5) W,COST,R
    5 FORMAT(3E10.3)
      RMIN=R
      W1=W
      DO 50 I=1,IVAL
      WRITE(6,9) VAL(I)
    9 FORMAT(5HOVAL=,E10.3)
      WRITE(6,7)
    7 FORMAT(109H     ALT        W        RKFT       Q        OVP       DY
     1NP     PARVEL     DENSTY    DENRAT       RHOU     OTHER  )
      OTHER=0.
      R=RMIN
       DO 50 J=1,IM
      KOUNT=0
      ALTCM=HOBKM(J)*1.E+5
         CALL ARDC(ALTCM,PRATIO,TRATIO,DRATIO)
      PSICTR=PRATIO*14.696
      PC=PRATIO*1.01325E+6
      W=W1
C     THIS IS THE SCALING FACTOR FOR 1KT.
      SCAFAC=.37*(.04/9.144)*HOBKM(J)
      IF(HOBKM(J).GT.9.144)SCAFAC=.33+(.04/9.144)*(HOBKM(J)-9.144)
      IF(HOBKM(J).GT.18.22)SCAFAC=.37+(.13/12.19)*(HOBKM(J)-18.22)
C     REMOVE THE NEXT CARD IF INTERPOLATING FOR THERMAL ENERGY
      IF(HOBKM(J).GT.18.222)W=W1*(1.-.12*(HOBKM(J)-18.222)/12.222)
      IF(COST) 8,24,8
    8 ALT=HOBKM(J)+R*COST
C     COST=COSINE THETA=-1. FOR DOWNWARD.
      IF(ALT.GE.0.) GO TO 12
        ALT=0.
        R=-HOBKM(J)/COST
   12 ALTCM=ALT*1.E+5
         CALL ARDC(ALTCM,PRATIO,TRATIO,DRATIO)
   24 PFACT=1./PRATIO
   13 RFACT=(W*PFACT)**.33333333
      RIKT=R/RFACT
         CALL RP12T1(RIKT,PIKT)
      OVP=PIKT/PFACT
      PSIAMB=PRATIO*14.696
      POVPA=OVP/PSIAMB
   16 IF(KOUNT) 17,17,20
   17 P1=OVP
      R1=R
      R=2.*R
      KOUNT=1
      GO TO 8
   20 P2=OVP
      R2=R

      AM=R1/R2
      BK=P1/P2
      CN=VAL(I)/P1
      A=ALOG(AM)
      B=ALOG(BM)
      C=ALOG(CN)
      ACB=A*C/B
      R=R1*EXP(ACB)
      P1=P2
      R1=R2
      IF(ABS(R-R2)-.0010*R2) 14,14,21
   21 KOUNT=KOUNT+1
      IF(KOUNT-20) 8,8,22
   22 WRITE(6,23)
   23 FORMAT(20H0FAILED TO CONVERGE.)
      GO TO 50
   14 RKFT=R/.3048
      DENSTY=0.076475*DRATIO*(7.0+6.0*POVPA)/(7.0+POVPA)
      DYNP=2.5*OVP*OVP/(7.*PSIAMB+OVP)
      Q=(7.95*W1*SCAFAC)/(R*R)
      DENRAT=(7.0+6.0*POVPA)/(7.0+POVPA)
      PARVEL=.714285*POVPA*1116.215*SQRT(TRATIO/(1.0+0.85714*POVPA))
      RHOU=PARVEL*DENSTY
      OTHER=P2
      WRITE(6,15) ALT,W,RKFT,Q,OVP,DYNP,PARVEL,DENSTY,DENRAT,RHOU,OTHER
   15 FORMAT (1H ,11E10.3)
   50 CONTINUE
      STOP
      END

[illegible]    9:40 AM    [illegible]    COMPILER
  0 MIN 20 SEC FOR COMPILATION PASS
  92 CARDS AT 300 CARDS PER MINUTE
  1036 DIGITS DATA,  5340 DIGITS CODE.
```

D. PEAK OVERPRESSURE PRINTOUT

```
    N         COST      RMIN
 .100E+01  .000E+00  .200E+00

VAL= .600E+01
  ALT        N         RKFT       Q         OVP       DYNP      PARVEL    DENSTY    DENRAT     RHOU      OTHER
 .000E+00  .100E+01  .115E+01  .242E+02  .600E+01  .620E-00  .200E+03  .970E-01  .126E+01  .274E+02  .600E+01
 .305E+01  .100E+01  .104E+01  .282E+02  .599E+01  .117E+01  .371E+03  .786E-01  .139E+01  .292E+02  .599E+01
 .610E+01  .100E+01  .939E+00  .320E+02  .599E+01  .160E+01  .493E+03  .637E-01  .150E+01  .315E+02  .599E+01
 .914E+01  .100E+01  .887E+00  .340E+02  .600E+01  .240E+01  .661E+03  .528E-01  .182E+01  .353E+02  .600E+01
 .122E+02  .100E+01  .830E+00  .427E+02  .599E+01  .337E+01  .893E+03  .413E-01  .219E+01  .371E+02  .599E+01
 .152E+02  .100E+01  .783E+00  .498E+02  .600E+01  .502E+01  .121E+04  .315E-01  .267E+01  .383E+02  .600E+01
 .183E+02  .100E+01  .741E+00  .577E+02  .599E+01  .669E+01  .162E+04  .237E-01  .323E+01  .384E+02  .599E+01
 .213E+02  .970E+00  .713E+00  .679E+02  .600E+01  .851E+01  .213E+04  .174E-01  .384E+01  .379E+02  .600E+01
 .244E+02  .940E+00  .686E+00  .797E+02  .600E+01  .102E+02  .273E+04  .124E-01  .438E+01  .342E+02  .600E+01
 .274E+02  .910E+00  .664E+00  .909E+02  .599E+01  .116E+02  .360E+04  .820E-02  .486E+01  .297E+02  .599E+01
 .305E+02  .880E+00  .646E+00  .103E+03  .600E+01  .126E+02  .466E+04  .539E-02  .521E+01  .251E+02  .600E+01

VAL= .400E+01
  ALT        N         RKFT       Q         OVP       DYNP      PARVEL    DENSTY    DENRAT     RHOU      OTHER
 .000E+00  .100E+01  .147E+01  .160E+02  .400E+01  .370E-00  .195E+03  .900E-01  .119E+01  .177E+02  .400E+01
 .305E+01  .100E+01  .132E+01  .175E+02  .400E+01  .539E-00  .263E+03  .716E-01  .127E+01  .188E+02  .400E+01
 .610E+01  .100E+01  .119E+01  .207E+02  .400E+01  .780E-00  .357E+03  .587E-01  .139E+01  .202E+02  .400E+01
 .914E+01  .100E+01  .109E+01  .237E+02  .399E+01  .115E+01  .486E+03  .452E-01  .158E+01  .220E+02  .399E+01
 .122E+02  .100E+01  .100E+01  .298E+02  .400E+01  .173E+01  .674E+03  .353E-01  .187E+01  .230E+02  .400E+01
 .152E+02  .100E+01  .941E+00  .345E+02  .399E+01  .251E+01  .935E+03  .266E-01  .225E+01  .243E+02  .399E+01
 .183E+02  .100E+01  .887E+00  .401E+02  .400E+01  .350E+01  .127E+04  .204E-01  .273E+01  .250E+02  .400E+01
 .213E+02  .970E+00  .833E+00  .497E+02  .400E+01  .466E+01  .169E+04  .151E-01  .333E+01  .253E+02  .400E+01
 .244E+02  .940E+00  .807E+00  .570E+02  .399E+01  .581E+01  .220E+04  .111E-01  .391E+01  .244E+02  .399E+01
 .274E+02  .910E+00  .769E+00  .678E+02  .400E+01  .693E+01  .291E+04  .759E-02  .446E+01  .221E+02  .400E+01
 .305E+02  .880E+00  .751E+00  .761E+02  .400E+01  .780E+01  .370E+04  .507E-02  .493E+01  .191E+02  .400E+01

VAL= .300E+01
  ALT        N         RKFT       Q         OVP       DYNP      PARVEL    DENSTY    DENRAT     RHOU      OTHER
 .000E+00  .100E+01  .173E+01  .100E+02  .300E+01  .213E-00  .150E+03  .879E-01  .114E+01  .131E+02  .300E+01
 .305E+01  .100E+01  .158E+01  .123E+02  .300E+01  .305E-00  .204E+03  .688E-01  .120E+01  .139E+02  .300E+01
 .610E+01  .100E+01  .141E+01  .147E+02  .300E+01  .447E-00  .280E+03  .529E-01  .130E+01  .148E+02  .300E+01
 .914E+01  .100E+01  .128E+01  .173E+02  .300E+01  .669E-00  .387E+03  .415E-01  .145E+01  .160E+02  .300E+01
 .122E+02  .100E+01  .116E+01  .220E+02  .300E+01  .100E+01  .545E+03  .317E-01  .168E+01  .173E+02  .300E+01
 .152E+02  .100E+01  .108E+01  .263E+02  .300E+01  .151E+01  .749E+03  .236E-01  .201E+01  .182E+02  .300E+01
 .183E+02  .100E+01  .101E+01  .308E+02  .300E+01  .215E+01  .100E+04  .177E-01  .244E+01  .187E+02  .300E+01
 .213E+02  .970E+00  .945E+00  .388E+02  .300E+01  .297E+01  .143E+04  .135E-01  .298E+01  .193E+02  .300E+01
 .244E+02  .940E+00  .887E+00  .474E+02  .300E+01  .389E+01  .188E+04  .101E-01  .358E+01  .187E+02  .300E+01
 .274E+02  .910E+00  .867E+00  .533E+02  .301E+01  .473E+01  .249E+04  .785E-02  .414E+01  .176E+02  .301E+01
 .305E+02  .880E+00  .831E+00  .621E+02  .300E+01  .544E+01  .305E+04  .479E-02  .464E+01  .156E+02  .300E+01

VAL= .200E+01
  ALT        N         RKFT       Q         OVP       DYNP      PARVEL    DENSTY    DENRAT     RHOU      OTHER
 .000E+00  .100E+01  .232E+01  .587E+01  .200E+01  .934E-01  .103E+03  .830E-01  .110E+01  .868E+01  .200E+01
 .305E+01  .100E+01  .202E+01  .749E+01  .200E+01  .137E-00  .141E+03  .643E-01  .114E+01  .905E+01  .200E+01
 .610E+01  .100E+01  .180E+01  .909E+01  .200E+01  .202E-00  .190E+03  .492E-01  .120E+01  .950E+01  .200E+01
 .914E+01  .100E+01  .161E+01  .109E+02  .200E+01  .306E-00  .275E+03  .374E-01  .131E+01  .103E+02  .200E+01
 .122E+02  .100E+01  .144E+01  .140E+02  .200E+01  .474E-00  .397E+03  .279E-01  .147E+01  .111E+02  .200E+01
 .152E+02  .100E+01  .131E+01  .179E+02  .200E+01  .710E-00  .573E+03  .203E-01  .172E+01  .116E+02  .200E+01
 .183E+02  .100E+01  .122E+01  .211E+02  .200E+01  .105E+01  .806E+03  .151E-01  .208E+01  .122E+02  .200E+01
 .213E+02  .970E+00  .114E+01  .267E+02  .200E+01  .152E+01  .121E+04  .114E-01  .252E+01  .127E+02  .200E+01
 .244E+02  .940E+00  .104E+01  .336E+02  .200E+01  .206E+01  .143E+04  .855E-02  .306E+01  .128E+02  .200E+01
 .274E+02  .910E+00  .101E+01  .397E+02  .209E+01  .265E+01  .199E+04  .621E-02  .369E+01  .123E+02  .200E+01
 .305E+02  .880E+00  .970E+00  .440E+02  .200E+01  .321E+01  .262E+04  .435E-02  .421E+01  .118E+02  .200E+01

VAL= .100E+01
  ALT        N         RKFT       Q         OVP       DYNP      PARVEL    DENSTY    DENRAT     RHOU      OTHER
 .000E+00  .100E+01  .387E+01  .209E+01  .100E+01  .201E-01  .527E+02  .802E-01  .105E+01  .423E+01  .100E+01
 .305E+01  .100E+01  .331E+01  .278E+01  .100E+01  .340E-01  .731E+02  .604E-01  .107E+01  .442E+01  .100E+01
 .610E+01  .100E+01  .284E+01  .369E+01  .100E+01  .510E-01  .103E+03  .450E-01  .110E+01  .465E+01  .100E+01
 .914E+01  .100E+01  .246E+01  .467E+01  .100E+01  .793E-01  .149E+03  .332E-01  .116E+01  .494E+01  .100E+01
 .122E+02  .100E+01  .214E+01  .603E+01  .100E+01  .124E-00  .221E+03  .238E-01  .125E+01  .521E+01  .100E+01
 .152E+02  .100E+01  .189E+01  .852E+01  .190E+01  .194E-00  .331E+03  .163E-01  .139E+01  .541E+01  .100E+01
 .183E+02  .100E+01  .172E+01  .107E+02  .998E-00  .290E-00  .484E+03  .117E-01  .159E+01  .580E+01  .998E-00
 .213E+02  .970E+00  .157E+01  .140E+02  .100E+01  .448E-00  .695E+03  .859E-02  .190E+01  .597E+01  .100E+01
 .244E+02  .940E+00  .140E+01  .170E+02  .998E-00  .643E-00  .959E+03  .649E-02  .229E+01  .625E+01  .998E-00
 .274E+02  .910E+00  .130E+01  .217E+02  .994E-00  .901E-00  .132E+04  .476E-02  .280E+01  .631E+01  .999E-00
 .305E+02  .880E+00  .120E+01  .263E+02  .100E+01  .119E+01  .177E+04  .347E-02  .330E+01  .615E+01  .100E+01

VAL= .500E+00
  ALT        N         RKFT       Q         OVP       DYNP      PARVEL    DENSTY    DENRAT     RHOU      OTHER
 .000E+00  .100E+01  .670E+01  .730E-00  .500E-00  .695E-02  .280E+02  .789E-01  .102E+01  .210E+01  .500E-00
 .305E+01  .100E+01  .560E+01  .957E-00  .500E-00  .876E-02  .373E+02  .585E-01  .104E+01  .218E+01  .500E-00
 .610E+01  .100E+01  .471E+01  .132E+01  .500E-00  .131E-01  .531E+02  .429E-01  .105E+01  .228E+01  .500E-00
 .914E+01  .100E+01  .394E+01  .183E+01  .500E-00  .201E-01  .775E+02  .310E-01  .108E+01  .240E+01  .500E-00
 .122E+02  .100E+01  .329E+01  .271E+01  .500E-00  .310E-01  .118E+03  .213E-01  .113E+01  .251E+01  .500E-00
 .152E+02  .100E+01  .287E+01  .371E+01  .500E-00  .503E-01  .181E+03  .142E-01  .120E+01  .257E+01  .500E-00
 .183E+02  .100E+01  .253E+01  .492E+01  .499E-00  .787E-01  .275E+03  .983E-02  .132E+01  .253E+01  .499E-00
 .213E+02  .970E+00  .224E+01  .686E+01  .500E-00  .123E-00  .411E+03  .674E-02  .149E+01  .278E+01  .500E-00
 .244E+02  .940E+00  .202E+01  .912E+01  .500E-00  .180E-00  .591E+03  .494E-02  .174E+01  .292E+01  .500E-00
 .274E+02  .910E+00  .187E+01  .115E+02  .500E-00  .275E-00  .845E+03  .357E-02  .210E+01  .302E+01  .500E-00
 .305E+02  .880E+00  .174E+01  .141E+02  .499E-00  .380E-00  .118E+04  .255E-02  .250E+01  .300E+01  .499E-00
```

E. DYNAMIC PRESSURE PROGRAM

```
*RJCL                                                                   C
FILE 5=MODSCK, UNIT = READER                                            C
      DIMENSION MOBKM(11),VAL(11)                                       C
    1 READ(5,2) W,COST,R,IM,IVAL                                        C
    2 FORMAT(3E10.3,2I2)                                                C
      READ(5,3) (MOBKM(I),I=1,IM)                                       C
    3 FORMAT(8E10.3)                                                    C
       READ(5,3) (VAL(I),I=1,IVAL)                                      C
      CALL CLOSE(5,ENPP)                                                C
      WRITE(6,4)                                                        C
    4 FORMAT(33H     W         COST       RMIN    )                     C
      WRITE(6,5) W,COST,R                                               C
    5 FORMAT(3E10.3)                                                    C
      RMIN=R                                                            C
      I=0                                                               C
      DO 50 I=1,IVAL                                                    C
      WRITE(6,9) VAL(I)                                                 C
    9 FORMAT(5HOVAL=,E10.3)                                             C
      WRITE(6,7)                                                        C
    7 FORMAT(109H    ALT        W        RKFT        B        OVP     DY C
     1NP      PARVEL      DENSTY      DENRAT        RHOU       OTHER  ) C
      OTHER=0.                                                          C
      R=RMIN                                                            C
       DO 50 J=1,IM                                                     C
      KOUNT=0                                                           C
      ALTCM=MOBKM(J)*1.E+5                                              C
          CALL ARDC(ALTCM,PRATIO,TRATIO,DRATIO)                         C
      PSICTR=PRATIO*14.696                                              C
      PC=PRATIO*1.01325E+6                                              C
      W=W1                                                              C
C     THIS IS THE SCALING FACTOR FOR INT.                               C
      SCAFAC=.37*(.09/9.144)*MOBKM(J)                                   C
      IF(MOBKM(J).GT.9.144)SCAFAC=.37+(.09/9.144)*(MOBKM(J)-9.144)      C
      IF(MOBKM(J).GT.10.22)SCAFAC=.37+(.13/12.19)*(MOBKM(J)-10.22)      C
C     REMOVE THE NEXT CARD IF INTERPOLATING FOR THERMAL ENERGY          C
      IF(MOBKM(J).GT.10.222)W=W1*(1.-.12*(MOBKM(J)-10.222)/12.222)      C
      IF(COST) 8,26,8                                                   C
    8 ALT=MOBKM(J)+R*COST                                               C
C     COST=COSINE THETA=-1. FOR DOWNWARD.                               C
      IF(ALT.GE.0.) GO TO 12                                            C
        ALT=0.                                                          C
        R=-MOBKM(J)/COST                                                C
   12 ALTCM=ALT*1.E+5                                                   C
          CALL ARDC(ALTCM,PRATIO,TRATIO,DRATIO)                         C
   26 PFACT=1./PRATIO                                                   C
   13 RFACT=(W*PFACT)**.33333333                                        C
      RIKT=R/RFACT                                                      C
          CALL RP1271(RIKT,PIKT)                                        C
      OVP=PIKT/PFACT                                                    C
      DYNP=2.5*OVP*OVP/(7.0*PSIAMB+OVP)                                 C
      PSIAMB=PRATIO*14.696                                              C
      POVPA=OVP/PSIAMB                                                  C
   16 IF(KOUNT) 17,17,20                                                C
   17 P1=DYNP                                                           C
      R1=R                                                              C
      R=2.*R                                                            C
      KOUNT=1                                                           C
      GO TO 8                                                           C
   20 P2=DYNP                                                           C
      R2=R                                                              C
      AN=R1/R2                                                          C
      BN=P1/P2                                                          C
      CN=VAL(I)/P1                                                      C
      A=ALOG(AN)                                                        C
      B=ALOG(BN)                                                        C
      C=ALOG(CN)                                                        C
      ACB=A*C/B                                                         C
      R=R1*EXP(ACB)                                                     C
      P1=P2                                                             C
      R1=R2                                                             C
      IF(ABS(R-R2)-.0010*R2) 14,14,21                                   C
   21 KOUNT=KOUNT+1                                                     C
      IF(KOUNT-20) 8,8,22                                               C
   22 WRITE(6,23)                                                       C
   23 FORMAT(20HOFAILED TO CONVERGE )                                   C
      GO TO 50                                                          C
   14 RKFT=R/.3048                                                      C
      DENSTY=0.076475*DRATIO*(7.0+6.0*POVPA)/(7.0+POVPA)                C
      B=(7.5*W1*SCAFAC)/(R*R)                                           C
      DENRAT=(7.0+6.0*POVPA)/(7.0+POVPA)                                C
      PARVEL=(1C485*POVPA*11)**.5)*SQRT(TRATIO)/(1.0+0.857*POVPA))      C
      RHOU=PARVEL*DENSTY                                                C
      OTHER=W2                                                          C
      WRITE(6,15) ALT,W,RKFT,B,OVP,DYNP,PARVEL,DENSTY,DENRAT,RHOU,OTHER C
   15 FORMAT (1H ,11E10.3)                                              C
   50 CONTINUE                                                          C
      STOP                                                              C
      END                                                             . C

.01/20/72     1:13 PM   3SN84.5    1/20/72    COMPILER
  0 MIN 50 SEC FOR COMPILATION PASS
   92 CARDS AT 108 CARDS PER MINUTE
  1636 DIGITS DATA,  3344 DIGITS COMP.
```

F. DYNAMIC PRESSURE PRINTOUT

```
     M        COST      RMIN
  .100E+01  .460E+00  .200E+00

VALU  .100E+00
   ALT        M        RKFT        Q         DVP       DYNP      PARVEL    DENSTY    DENRAT     RHOU      OTHER
  .000E+00  .100E+01  [illegible] .664E+01 .205E+02  .999E-01  .339E+03  .889E-01  .110E+01  .882E+01  .999E-01
  .305E+01  .100E+01  .225E+01  .653E+01  .170E+01  .120E+00  .121E+03  .631E-01  .112E+01  .765E+01  .100E-00
  .610E+01  .100E+01  .229E+01  .583E+01  .140E+01  .100E-00  .141E+03  .480E-01  .114E+01  .637E+01  .100E-00
  .914E+01  .100E+01  .229E+01  .540E+01  .113E+01  .098E-01  .166E+03  .334E-01  .114E+01  .559E+01  .998E-01
  .122E+02  .100E+01  .229E+01  .560E+01  .894E-00  .998E-01  .203E+03  .231E-01  .122E+01  .463E+01  .998E-01
  .152E+02  .100E+01  .232E+01  .567E+01  .711E-00  .160E-00  .248E+03  .151E-01  .128E+01  .374E+01  .100E-00
  .183E+02  .100E+01  .233E+01  .574E+01  .563E-00  .100E-00  .303E+03  .994E-02  .135E+01  .303E+01  .100E-00
  .213E+02  .976E-00  .236E+01  .680E+01  .446E-00  .109E-00  .376E+03  .655E-02  .145E+01  .246E+01  .100E-00
  .244E+02  .940E-00  .242E+01  .669E+01  .352E-00  .100E-00  .459E+03  .441E-02  .155E+01  .202E+01  .100E-00
  .274E+02  .910E-00  .244E+01  .674E+01  .267E-00  .160E-00  .567E+03  .230E-02  .170E+01  .163E+01  .100E-00
  .305E+02  .880E-00  .247E+01  .690E+01  .213E-00  .995E-01  .698E+03  .192E-02  .186E+01  .133E+01  .998E-01

VALU  .500E-00
   ALT        M        RKFT        Q         DVP       DYNP      PARVEL    DENSTY    DENRAT     RHOU      OTHER
  .000E+00  .100E+01  .130E+01  .177E+02  .400E+01  .500E-00  .223E+03  .939E-01  .122E+01  .200E+02  .500E-00
  .305E+01  .100E+01  .135E+01  .160E+02  .366E+01  .500E-00  .255E+03  .711E-01  .126E+01  .182E+02  .500E-00
  .610E+01  .100E+01  .137E+01  .137E+02  .314E+01  .500E-00  .298E+03  .538E-01  .131E+01  .153E+02  .500E-00
  .914E+01  .100E+01  .138E+01  .168E+02  .250E+01  .501E-00  .341E+03  .392E-01  .139E+01  .136E+02  .501E-00
  .122E+02  .100E+01  .140E+01  .160E+02  .208E+01  .500E-00  .400E+03  .281E-01  .149E+01  .114E+02  .500E-00
  .152E+02  .100E+01  .145E+01  .145E+02  .165E+01  .499E-00  .494E+03  .189E-01  .161E+01  .936E+01  .499E-00
  .183E+02  .100E+01  .149E+01  .143E+02  .132E+01  .501E-00  .600E+03  .121E-01  .174E+01  .770E+01  .501E-00
  .213E+02  .970E-00  .152E+01  .149E+02  .106E+01  .500E-00  .726E+03  .079E-02  .194E+01  .630E+01  .500E-00
  .244E+02  .940E-00  .153E+01  .153E+02  .865E-00  .500E-00  .871E+03  .611E-02  .216E+01  .532E+01  .500E-00
  .274E+02  .910E-00  .160E+01  .157E+02  .703E-00  .499E-00  .106E+04  .411E-02  .242E+01  .436E+01  .499E-00
  .305E+02  .880E-00  .162E+01  .182E+02  .566E-00  .500E-00  .129E+04  .280E-02  .271E+01  .360E+01  .500E-00

VALU  .100E+01
   ALT        M        RKFT        Q         DVP       DYNP      PARVEL    DENSTY    DENRAT     RHOU      OTHER
  .000E+00  .100E+01  .103E+01  .276E+02  .662E+01  .100E+01  .303E+03  .906E-01  .139E+01  .304E+02  .100E+01
  .305E+01  .100E+01  .105E+01  .257E+02  .552E+01  .100E+01  .347E+03  .770E-01  .136E+01  .247E+02  .100E+01
  .610E+01  .100E+01  .112E+01  .239E+02  .455E+01  .100E+01  .397E+03  .587E-01  .144E+01  .233E+02  .100E+01
  .914E+01  .100E+01  .114E+01  .219E+02  .370E+01  .100E+01  .454E+03  .441E-01  .154E+01  .202E+02  .100E+01
  .122E+02  .100E+01  .116E+01  .210E+02  .297E+01  .997E-00  .541E+03  .310E-01  .167E+01  .171E+02  .997E-00
  .152E+02  .100E+01  .120E+01  .212E+02  .239E+01  .999E-00  .656E+03  .216E-01  .183E+01  .141E+02  .999E-00
  .183E+02  .100E+01  .125E+01  .208E+02  .193E+01  .100E+01  .793E+03  .149E-01  .203E+01  .118E+02  .100E+01
  .213E+02  .976E-00  .127E+01  .214E+02  .157E+01  .100E+01  .948E+03  .103E-01  .228E+01  .977E+01  .100E+01
  .244E+02  .940E-00  .130E+01  .221E+02  .129E+01  .100E+01  .113E+04  .723E-02  .255E+01  .818E+01  .100E+01
  .274E+02  .910E-00  .132E+01  .230E+02  .107E+01  .100E+01  .138E+04  .480E-02  .280E+01  .673E+01  .100E+01
  .305E+02  .880E-00  .134E+01  .240E+02  .898E-00  .998E-00  .157E+04  .332E-02  .322E+01  .553E+01  .998E-00

VALU  .150E+01
   ALT        M        RKFT        Q         DVP       DYNP      PARVEL    DENSTY    DENRAT     RHOU      OTHER
  .000E+00  .100E+01  .950E-00  .360E+02  .910E+01  .150E+01  .366E+03  .105E-00  .137E+01  .381E+02  .150E+01
  .305E+01  .100E+01  .975E-00  .321E+02  .682E+01  .150E+01  .413E+03  .814E-01  .144E+01  .336E+02  .150E+01
  .610E+01  .100E+01  .998E-00  .299E+02  .564E+01  .150E+01  .472E+03  .627E-01  .153E+01  .295E+02  .150E+01
  .914E+01  .100E+01  .101E+01  .276E+02  .450E+01  .150E+01  .541E+03  .474E-01  .165E+01  .256E+02  .150E+01
  .122E+02  .100E+01  .104E+01  .270E+02  .370E+01  .150E+01  .637E+03  .342E-01  .181E+01  .218E+02  .150E+01
  .152E+02  .100E+01  .108E+01  .262E+02  .269E+01  .150E+01  .767E+03  .236E-01  .209E+01  .181E+02  .150E+01
  .183E+02  .100E+01  .111E+01  .255E+02  .243E+01  .150E+01  .925E+03  .164E-01  .223E+01  .151E+02  .150E+01
  .213E+02  .970E-00  .114E+01  .265E+02  .199E+01  .151E+01  .111E+04  .114E-01  .251E+01  .124E+02  .151E+01
  .244E+02  .940E-00  .120E+01  .270E+02  .164E+01  .150E+01  .132E+04  .849E-02  .292E+01  .103E+02  .150E+01
  .274E+02  .910E-00  .118E+01  .289E+02  .137E+01  .150E+01  .160E+04  .541E-02  .318E+01  .844E+01  .150E+01
  .305E+02  .880E-00  .119E+01  .305E+02  .118E+01  .151E+01  .195E+04  .368E-02  .354E+01  .718E+01  .151E+01

VALU  .200E+01
   ALT        M        RKFT        Q         DVP       DYNP      PARVEL    DENSTY    DENRAT     RHOU      OTHER
  .000E+00  .100E+01  .891E-00  .408E+02  .947E+01  .199E+01  .412E+03  .109E-00  .142E+01  .448E+02  .199E+01
  .305E+01  .100E+01  .907E-00  .339E+02  .793E+01  .200E+01  .467E+03  .850E-01  .150E+01  .397E+02  .200E+01
  .610E+01  .100E+01  .919E-00  .338E+02  .658E+01  .204E+01  .531E+03  .650E-01  .161E+01  .349E+02  .200E+01
  .914E+01  .100E+01  .935E-00  .324E+02  .537E+01  .269E+01  .609E+03  .501E-01  .175E+01  .305E+02  .200E+01
  .122E+02  .100E+01  .967E-00  .315E+02  .433E+01  .200E+01  .716E+03  .364E-01  .192E+01  .260E+02  .200E+01
  .152E+02  .100E+01  .100E+01  .305E+02  .351E+01  .200E+01  .857E+03  .252E-01  .214E+01  .216E+02  .200E+01
  .183E+02  .100E+01  .103E+01  .290E+02  .287E+01  .200E+01  .103E+04  .179E-01  .239E+01  .180E+02  .200E+01
  .213E+02  .970E-00  .106E+01  .309E+02  .235E+01  .200E+01  .123E+04  .122E-01  .270E+01  .150E+02  .200E+01
  .244E+02  .940E-00  .107E+01  .325E+02  .197E+01  .200E+01  .147E+04  .805E-02  .304E+01  .120E+02  .200E+01
  .274E+02  .910E-00  .108E+01  .341E+02  .164E+01  .200E+01  .170E+04  .550E-02  .341E+01  .124E+02  .230E+01
  .305E+02  .880E-00  .111E+01  .360E+02  .145E+01  .202E+01  .211E+04  .393E-02  .380E+01  .894E+01  .200E+01

VALU  .250E+01
   ALT        M        RKFT        Q         DVP       DYNP      PARVEL    DENSTY    DENRAT     RHOU      OTHER
  .000E+00  .100E+01  .877E-00  .493E+02  .101E+02  .250E+01  .456E+03  .112E-00  .147E+01  .510E+02  .250E+01
  .305E+01  .100E+01  .861E-00  .432E+02  .893E+01  .250E+01  .513E+03  .882E-01  .156E+01  .452E+02  .250E+01
  .610E+01  .100E+01  .857E-00  .401E+02  .730E+01  .249E+01  .592E+03  .683E-01  .168E+01  .397E+02  .249E+01
  .914E+01  .100E+01  .882E-00  .363E+02  .605E+01  .250E+01  .645E+03  .523E-01  .183E+01  .348E+02  .250E+01
  .122E+02  .100E+01  .912E-00  .353E+02  .490E+01  .250E+01  .779E+03  .383E-01  .202E+01  .298E+02  .250E+01
  .152E+02  .100E+01  .942E-00  .344E+02  .399E+01  .250E+01  .934E+03  .266E-01  .225E+01  .248E+02  .250E+01
  .183E+02  .100E+01  .975E-00  .333E+02  .327E+01  .250E+01  .112E+04  .180E-01  .253E+01  .207E+02  .250E+01
  .213E+02  .970E-00  .903E-00  .350E+02  .270E+01  .250E+01  .134E+04  .127E-01  .285E+01  .173E+02  .253E+01
  .244E+02  .940E-00  .101E+01  .368E+02  .230E+01  .250E+01  .163E+04  .902E-02  .321E+01  .145E+02  .250E+01
  .274E+02  .910E-00  .102E+01  .387E+02  .192E+01  .250E+01  .194E+04  .612E-02  .360E+01  .119E+02  .250E+01
  .305E+02  .880E-00  .105E+01  .387E+02  .161E+01  .250E+01  .237E+04  .415E-02  .399E+01  .977E+01  .250E+01
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G. PARTICLE VELOCITY PRINTOUT

```
     W         COS.       WMIN
 .100E+01   .000E+00   .200E-00

VAL=  .250E+02
   ALT        W         RKFT        A          DVP        DYNP      PARVEL     DENSTY     DENRAT      RHOU      OTHER
 .000E+00  .100E+01  .708E+01  .633E+00  .467E+00  .520E-02  .250E+02  .782E-01  .102E+01  .196E+01  .250E+02
 .305E+01  .100E+01  .779E+01  .505E+00  .333E+00  .390E-02  .250E+02  .578E-01  .102E+01  .145E+01  .250E+02
 .610E+01  .100E+01  .866E+01  .394E+00  .232E+00  .272E-02  .250E+02  .418E-01  .102E+01  .104E+01  .250E+02
 .914E+01  .100E+01  .960E+01  .303E+00  .156E+00  .198E-02  .250E+02  .294E-01  .103E+01  .734E+00  .250E+02
 .122E+02  .100E+01  .111E+02  .241E+00  .130E+00  .131E-02  .250E+02  .194E-01  .103E+01  .485E+00  .250E+02
 .152E+02  .100E+01  .129E+02  .183E+00  .625E-01  .816E-03  .250E+02  .121E-01  .103E+01  .302E+00  .250E+02
 .182E+02  .100E+01  .151E+02  .130E+00  .389E-01  .506E-03  .250E+02  .753E-02  .103E+01  .188E+00  .250E+02
 .213E+02  .970E+00  .178E+02  .111E+00  .240E-01  .314E-03  .250E+02  .465E-02  .103E+01  .116E+00  .250E+02
 .243E+02  .940E+00  .204E+02  .697E-01  .150E-01  .196E-03  .250E+02  .291E-02  .103E+01  .724E-01  .250E+02
 .274E+02  .910E+00  .240E+02  .699E-01  .916E-02  .118E-03  .250E+02  .174E-02  .103E+01  .436E-01  .250E+02
 .305E+02  .880E+00  .288E+02  .546E-01  .567E-02  .713E-04  .250E+02  .109E-02  .103E+01  .265E-01  .250E+02

VAL=  .500E+02
   ALT        W         RKFT        A          DVP        DYNP      PARVEL     DENSTY     DENRAT      RHOU      OTHER
 .000E+00  .100E+01  .400E+01  .192E+01  .946E+00  .214E-01  .500E+02  .800E-01  .105E+01  .400E+01  .500E+02
 .305E+01  .100E+01  .437E+01  .153E+01  .673E+00  .100E-01  .500E+02  .592E-01  .105E+01  .296E+01  .500E+02
 .610E+01  .100E+01  .496E+01  .120E+01  .470E+00  .135E-01  .500E+02  .620E-01  .105E+01  .214E+01  .500E+02
 .914E+01  .100E+01  .554E+01  .922E+00  .317E+00  .813E-02  .500E+02  .301E-01  .105E+01  .151E+01  .500E+02
 .122E+02  .100E+01  .633E+01  .734E+00  .224E+00  .537E-02  .500E+02  .199E-01  .105E+01  .995E+00  .500E+02
 .152E+02  .100E+01  .741E+01  .550E+00  .127E+00  .335E-02  .500E+02  .124E-01  .105E+01  .620E+00  .500E+02
 .182E+02  .100E+01  .860E+01  .421E+00  .791E-01  .208E-02  .500E+02  .773E-02  .105E+01  .386E+00  .500E+02
 .213E+02  .970E+00  .101E+02  .339E+00  .488E-01  .129E-02  .500E+02  .477E-02  .105E+01  .238E+00  .500E+02
 .243E+02  .940E+00  .117E+02  .273E+00  .305E-01  .804E-03  .500E+02  .298E-02  .105E+01  .149E+00  .500E+02
 .274E+02  .910E+00  .137E+02  .213E+00  .186E-01  .482E-03  .500E+02  .179E-02  .105E+01  .894E-01  .500E+02
 .305E+02  .880E+00  .161E+02  .166E+00  .115E-01  .293E-03  .500E+02  .109E-02  .105E+01  .543E-01  .500E+02

VAL=  .750E+02
   ALT        W         RKFT        A          DVP        DYNP      PARVEL     DENSTY     DENRAT      RHOU      OTHER
 .000E+00  .100E+01  .795E+01  .365E+01  .144E+01  .496E-01  .750E+02  .818E-01  .107E+01  .613E+01  .750E+02
 .305E+01  .100E+01  .325E+01  .290E+01  .113E+01  .368E-01  .750E+02  .605E-01  .107E+01  .454E+01  .750E+02
 .610E+01  .100E+01  .361E+01  .226E+01  .715E+00  .266E-01  .750E+02  .438E-01  .107E+01  .329E+01  .750E+02
 .914E+01  .100E+01  .404E+01  .172E+01  .483E+00  .188E-01  .750E+02  .307E-01  .108E+01  .232E+01  .750E+02
 .122E+02  .100E+01  .462E+01  .138E+01  .310E+00  .124E-01  .750E+02  .209E-01  .108E+01  .153E+01  .750E+02
 .152E+02  .100E+01  .541E+01  .104E+01  .193E+00  .773E-02  .750E+02  .127E-01  .108E+01  .955E+00  .750E+02
 .182E+02  .100E+01  .634E+01  .780E+00  .120E+00  .481E-02  .750E+02  .793E-02  .108E+01  .595E+00  .750E+02
 .213E+02  .970E+00  .737E+01  .633E+00  .744E-01  .297E-02  .750E+02  .489E-02  .108E+01  .367E+00  .750E+02
 .243E+02  .940E+00  .853E+01  .512E+00  .465E-01  .186E-02  .750E+02  .304E-02  .108E+01  .229E+00  .750E+02
 .274E+02  .910E+00  .100E+02  .399E+00  .283E-01  .111E-02  .750E+02  .183E-02  .108E+01  .138E+00  .750E+02
 .305E+02  .880E+00  .117E+02  .312E+00  .174E-01  .676E-03  .750E+02  .111E-02  .108E+01  .835E-01  .750E+02

VAL=  .100E+03
   ALT        W         RKFT        A          DVP        DYNP      PARVEL     DENSTY     DENRAT      RHOU      OTHER
 .000E+00  .100E+01  .230E+01  .567E+01  .194E+01  .902E-01  .100E+03  .836E-01  .109E+01  .826E+01  .100E+03
 .305E+01  .100E+01  .262E+01  .448E+01  .139E+01  .669E-01  .100E+03  .619E-01  .110E+01  .620E+01  .100E+03
 .610E+01  .100E+01  .291E+01  .346E+01  .967E+00  .484E-01  .100E+03  .449E-01  .110E+01  .449E+01  .100E+03
 .914E+01  .100E+01  .328E+01  .268E+01  .554E+00  .342E-01  .100E+03  .317E-01  .110E+01  .317E+01  .100E+03
 .122E+02  .100E+01  .373E+01  .211E+01  .420E+00  .225E-01  .999E+02  .209E-01  .111E+01  .209E+01  .999E+02
 .152E+02  .100E+01  .437E+01  .160E+01  .262E+00  .141E-01  .100E+03  .131E-01  .111E+01  .131E+01  .100E+03
 .182E+02  .100E+01  .511E+01  .121E+01  .163E+00  .877E-02  .100E+03  .813E-02  .111E+01  .813E+00  .100E+03
 .213E+02  .970E+00  .594E+01  .977E+00  .101E+00  .541E-02  .100E+03  .502E-02  .111E+01  .502E+00  .100E+03
 .243E+02  .940E+00  .683E+01  .787E+00  .629E-01  .338E-02  .100E+03  .314E-02  .111E+01  .314E+00  .100E+03
 .274E+02  .910E+00  .809E+01  .613E+00  .383E-01  .202E-02  .999E+02  .188E-02  .111E+01  .188E+00  .999E+02
 .305E+02  .880E+00  .948E+01  .479E+00  .238E-01  .123E-02  .100E+03  .114E-02  .110E+01  .114E+00  .100E+03

VAL=  .125E+03
   ALT        W         RKFT        A          DVP        DYNP      PARVEL     DENSTY     DENRAT      RHOU      OTHER
 .000E+00  .100E+01  .199E+01  .797E+01  .247E+01  .144E+00  .125E+03  .853E-01  .112E+01  .107E+02  .125E+03
 .305E+01  .100E+01  .220E+01  .631E+01  .176E+01  .107E+00  .125E+03  .634E-01  .112E+01  .793E+01  .125E+03
 .610E+01  .100E+01  .245E+01  .490E+01  .123E+01  .776E-01  .125E+03  .459E-01  .113E+01  .575E+01  .125E+03
 .914E+01  .100E+01  .275E+01  .376E+01  .830E+00  .547E-01  .125E+03  .325E-01  .113E+01  .408E+01  .125E+03
 .122E+02  .100E+01  .315E+01  .296E+01  .534E+00  .362E-01  .125E+03  .215E-01  .114E+01  .268E+01  .125E+03
 .152E+02  .100E+01  .369E+01  .224E+01  .333E+00  .226E-01  .125E+03  .134E-01  .114E+01  .167E+01  .125E+03
 .182E+02  .100E+01  .432E+01  .169E+01  .207E+00  .141E-01  .125E+03  .834E-02  .114E+01  .104E+01  .125E+03
 .213E+02  .970E+00  .503E+01  .137E+01  .128E+00  .867E-02  .125E+03  .519E-02  .114E+01  .643E+00  .125E+03
 .243E+02  .940E+00  .582E+01  .110E+01  .799E-01  .542E-02  .125E+03  .325E-02  .114E+01  .402E+00  .125E+03
 .274E+02  .910E+00  .683E+01  .880E+00  .487E-01  .325E-02  .125E+03  .193E-02  .113E+01  .241E+00  .125E+03
 .305E+02  .880E+00  .798E+01  .674E+00  .301E-01  .197E-02  .125E+03  .117E-02  .113E+01  .144E+00  .125E+03

VAL=  .150E+03
   ALT        W         RKFT        A          DVP        DYNP      PARVEL     DENSTY     DENRAT      RHOU      OTHER
 .000E+00  .100E+01  .175E+01  .104E+02  .300E+01  .212E+00  .150E+03  .873E-01  .114E+01  .131E+02  .150E+03
 .305E+01  .100E+01  .193E+01  .819E+01  .214E+01  .157E+00  .150E+03  .646E-01  .115E+01  .971E+01  .150E+03
 .610E+01  .100E+01  .216E+01  .628E+01  .149E+01  .114E+00  .150E+03  .470E-01  .115E+01  .705E+01  .150E+03
 .914E+01  .100E+01  .243E+01  .472E+01  .101E+01  .805E-01  .150E+03  .332E-01  .116E+01  .498E+01  .150E+03
 .122E+02  .100E+01  .280E+01  .367E+01  .650E+00  .535E-01  .150E+03  .220E-01  .118E+01  .330E+01  .150E+03
 .152E+02  .100E+01  .331E+01  .277E+01  .405E+00  .333E-01  .150E+03  .137E-01  .116E+01  .206E+01  .150E+03
 .182E+02  .100E+01  .387E+01  .211E+01  .252E+00  .208E-01  .150E+03  .853E-02  .116E+01  .128E+01  .150E+03
 .213E+02  .970E+00  .450E+01  .172E+01  .158E+00  .128E-01  .150E+03  .527E-02  .116E+01  .781E+00  .150E+03
 .243E+02  .940E+00  .521E+01  .137E+01  .974E-01  .801E-02  .150E+03  .330E-02  .116E+01  .495E+00  .150E+03
 .274E+02  .910E+00  .610E+01  .109E+01  .593E-01  .480E-02  .150E+03  .197E-02  .116E+01  .296E+00  .150E+03
 .305E+02  .880E+00  .709E+01  .852E+00  .367E-01  .291E-02  .150E+03  .120E-02  .115E+01  .180E+00  .150E+03
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H. DENSITY RATIO PRINTOUT

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     W         COST       RRIN
 .100E+01   .000E+00   .200E-00

VAL=  .120E+01
    ALT         W        MKFT        Q         DVP       DYNP      PARVEL    DENSTY    DENRAT      RHOU      OTHER
 .000E+00  .100E+01  .141E+01  .150E+02  .429E+01  .430E-00  .208E+03  .918E-01  .120E+01  .191E+02  .120E+01
 .305E+01  .100E+01  .139E+01  .121E+02  .293E+01  .293E-00  .201E+03  .674E-01  .120E+01  .136E+02  .120E+01
 .610E+01  .100E+01  .192E+01  .857E+01  .197E+01  .197E-00  .193E+03  .489E-01  .120E+01  .946E+01  .120E+01
 .914E+01  .100E+01  .211E+01  .638E+01  .128E+01  .128E-00  .185E+03  .344E-01  .120E+01  .638E+01  .120E+01
 .122E+02  .100E+01  .240E+01  .485E+01  .796E-00  .796E-01  .190E+03  .227E-01  .120E+01  .409E+01  .120E+01
 .152E+02  .100E+01  .288E+01  .367E+01  .497E-00  .496E-01  .180E+03  .141E-01  .120E+01  .255E+01  .120E+01
 .182E+02  .100E+01  .336E+01  .278E+01  .309E-00  .309E-01  .180E+03  .881E-02  .120E+01  .159E+01  .120E+01
 .213E+02  .970E+00  .393E+01  .229E+01  .191E-00  .191E-01  .180E+03  .544E-02  .120E+01  .980E+00  .120E+01
 .243E+02  .940E+00  .454E+01  .180E+01  .119E-00  .119E-01  .180E+03  .340E-02  .120E+01  .613E+00  .120E+01
 .274E+02  .910E+00  .527E+01  .144E+01  .739E-01  .739E-02  .183E+03  .204E-02  .120E+01  .374E+00  .120E+01
 .305E+02  .880E+00  .607E+01  .116E+01  .468E-01  .468E-02  .187E+03  .124E-02  .120E+01  .232E+00  .120E+01

VAL=  .150E+01
    ALT         W        MKFT        Q         DVP       DYNP      PARVEL    DENSTY    DENRAT      RHOU      OTHER
 .000E+00  .100E+01  .795E+00  .521E+02  .114E+02  .285E+01  .480E+03  .112E-00  .150E+01  .550E+02  .150E+01
 .305E+01  .100E+01  .901E+00  .370E+02  .785E+01  .196E+01  .463E+03  .847E-01  .150E+01  .392E+02  .150E+01
 .610E+01  .100E+01  .103E+01  .277E+02  .525E+01  .131E+01  .446E+03  .612E-01  .150E+01  .273E+02  .150E+01
 .914E+01  .100E+01  .119E+01  .199E+02  .340E+01  .848E-00  .427E+03  .430E-01  .150E+01  .168E+02  .150E+01
 .122E+02  .100E+01  .139E+01  .151E+02  .212E+01  .529E-00  .414E+03  .283E-01  .150E+01  .119E+02  .150E+01
 .152E+02  .100E+01  .163E+01  .113E+02  .132E+01  .330E-00  .416E+03  .177E-01  .150E+01  .735E+01  .150E+01
 .182E+02  .100E+01  .191E+01  .868E+01  .823E+00  .205E-00  .416E+03  .110E-01  .150E+01  .450E+01  .150E+01
 .213E+02  .970E+00  .222E+01  .700E+01  .508E-00  .127E-00  .416E+03  .679E-02  .150E+01  .282E+01  .150E+01
 .243E+02  .940E+00  .257E+01  .564E+01  .318E-00  .793E-01  .414E+03  .425E-02  .150E+01  .177E+01  .150E+01
 .274E+02  .910E+00  .290E+01  .450E+01  .167E-00  .491E-01  .422E+03  .255E-02  .150E+01  .108E+01  .150E+01
 .305E+02  .880E+00  .344E+01  .363E+01  .124E-00  .311E-01  .431E+03  .155E-02  .150E+01  .668E-00  .150E+01

VAL=  .180E+01
    ALT         W        MKFT        Q         DVP       DYNP      PARVEL    DENSTY    DENRAT      RHOU      OTHER
 .000E+00  .100E+01  .600E-00  .880E+02  .196E+02  .786E+01  .727E+03  .139E-00  .180E+01  .100E+03  .180E+01
 .305E+01  .100E+01  .690E-00  .661E+02  .139E+02  .546E+01  .701E+03  .104E-00  .180E+01  .714E+02  .180E+01
 .610E+01  .100E+01  .778E-00  .488E+02  .902E+01  .361E+01  .675E+03  .735E-01  .180E+01  .496E+02  .180E+01
 .914E+01  .100E+01  .899E-00  .350E+02  .584E+01  .234E+01  .648E+03  .510E-01  .180E+01  .334E+02  .180E+01
 .122E+02  .100E+01  .105E+01  .264E+02  .365E+01  .146E+01  .630E+03  .341E-01  .180E+01  .215E+02  .180E+01
 .152E+02  .100E+01  .123E+01  .201E+02  .227E+01  .910E-00  .630E+03  .212E-01  .180E+01  .134E+02  .180E+01
 .182E+02  .100E+01  .144E+01  .152E+02  .142E+01  .567E-00  .630E+03  .132E-01  .180E+01  .833E+01  .180E+01
 .213E+02  .970E+00  .168E+01  .123E+02  .873E-00  .350E-00  .633E+03  .818E-02  .180E+01  .514E+01  .180E+01
 .243E+02  .940E+00  .194E+01  .989E+01  .546E-00  .219E-00  .630E+03  .519E-02  .180E+01  .321E+01  .180E+01
 .274E+02  .910E+00  .225E+01  .790E+01  .338E-00  .135E-00  .640E+03  .306E-02  .180E+01  .198E+01  .180E+01
 .305E+02  .880E+00  .259E+01  .638E+01  .214E-00  .857E-01  .653E+03  .186E-02  .180E+01  .172E+01  .180E+01

VAL=  .200E+01
    ALT         W        MKFT        Q         DVP       DYNP      PARVEL    DENSTY    DENRAT      RHOU      OTHER
 .000E+00  .100E+01  .527E-00  .114E+03  .257E+02  .129E+02  .882E+03  .153E-00  .200E+01  .135E+03  .200E+01
 .305E+01  .100E+01  .597E-00  .858E+02  .177E+02  .884E+01  .851E+03  .113E-00  .200E+01  .962E+02  .200E+01
 .610E+01  .100E+01  .683E-00  .631E+02  .118E+02  .591E+01  .819E+03  .818E-01  .200E+01  .668E+02  .200E+01
 .914E+01  .100E+01  .789E-00  .458E+02  .765E+01  .382E+01  .786E+03  .57 E-01  .200E+01  .451E+02  .200E+01
 .122E+02  .100E+01  .924E-00  .345E+02  .478E+01  .239E+01  .765E+03  .378E-01  .200E+01  .289E+02  .200E+01
 .152E+02  .100E+01  .108E+01  .261E+02  .298E+01  .149E+01  .765E+03  .236E-01  .200E+01  .180E+02  .200E+01
 .182E+02  .100E+01  .127E+01  .198E+02  .185E+01  .927E-00  .765E+03  .147E-01  .200E+01  .112E+02  .200E+01
 .213E+02  .970E+00  .147E+01  .159E+02  .114E+01  .572E-00  .765E+03  .906E-02  .200E+01  .693E+01  .200E+01
 .243E+02  .940E+00  .170E+01  .128E+02  .716E-00  .358E-00  .765E+03  .56 E-02  .200E+01  .433E+01  .200E+01
 .274E+02  .910E+00  .196E+01  .103E+02  .443E-00  .222E-00  .777E+03  .340E-02  .200E+01  .264E+01  .200E+01
 .305E+02  .880E+00  .225E+01  .828E+01  .280E-00  .140E-00  .793E+03  .207E-02  .200E+01  .164E+01  .200E+01

VAL=  .230E+01
    ALT         W        MKFT        Q         DVP       DYNP      PARVEL    DENSTY    DENRAT      RHOU      OTHER
 .000E+00  .100E+01  .449E-00  .157E+03  .362E+02  .235E+02  .101E+04  .176E-00  .230E+01  .196E+03  .230E+01
 .305E+01  .100E+01  .509E-00  .118E+03  .249E+02  .162E+02  .107E+04  .130E-00  .230E+01  .139E+03  .230E+01
 .610E+01  .100E+01  .592E-00  .868E+02  .166E+02  .108E+02  .103E+04  .938E-01  .230E+01  .969E+02  .230E+01
 .914E+01  .100E+01  .673E-00  .623E+02  .108E+02  .699E+01  .991E+03  .657E-01  .230E+01  .453E+02  .230E+01
 .122E+02  .100E+01  .780E-00  .474E+02  .672E+01  .437E+01  .964E+03  .435E-01  .230E+01  .419E+02  .230E+01
 .152E+02  .100E+01  .922E-00  .359E+02  .419E+01  .272E+01  .964E+03  .27 E-01  .230E+01  .261E+02  .230E+01
 .182E+02  .100E+01  .100E+01  .272E+02  .261E+01  .169E+01  .944E+03  .169E-01  .230E+01  .163E+02  .230E+01
 .213E+02  .970E+00  .126E+01  .219E+02  .151E+01  .105E+01  .964E+03  .104E-01  .230E+01  .100E+02  .230E+01
 .243E+02  .940E+00  .145E+01  .176E+02  .101E+01  .654E-00  .964E+03  .65 E-02  .230E+01  .628E+01  .230E+01
 .274E+02  .910E+00  .169E+01  .141E+02  .623E-00  .405E-00  .980E+03  .391E-02  .230E+01  .383E+01  .230E+01
 .305E+02  .880E+00  .194E+01  .114E+02  .394E-00  .256E-00  .999E+03  .238E-02  .230E+01  .230E+01  .230E+01

VAL=  .250E+01
    ALT         W        MKFT        Q         DVP       DYNP      PARVEL    DENSTY    DENRAT      RHOU      OTHER
 .000E+00  .100E+01  .411E-00  .188E+03  .441E+02  .331E+02  .127E+04  .19 E-00  .250E+01  .242E+03  .250E+01
 .305E+01  .100E+01  .466E-00  .141E+03  .303E+02  .227E+02  .122E+04  .141E-00  .250E+01  .173E+03  .250E+01
 .610E+01  .100E+01  .532E-00  .104E+03  .203E+02  .152E+02  .116E+04  .102E-00  .250E+01  .120E+03  .250E+01
 .914E+01  .100E+01  .618E-00  .746E+02  .131E+02  .984E+01  .113E+04  .71 E-01  .250E+01  .808E+02  .250E+01
 .122E+02  .100E+01  .720E-00  .547E+02  .819E+01  .614E+01  .110E+04  .473E-01  .250E+01  .519E+02  .250E+01
 .152E+02  .100E+01  .843E-00  .430E+02  .511E+01  .383E+01  .110E+04  .29 E-01  .250E+01  .323E+02  .250E+01
 .182E+02  .100E+01  .947E-00  .325E+02  .319E+01  .239E+01  .110E+04  .183E-01  .250E+01  .201E+02  .250E+01
 .213E+02  .970E+00  .115E+01  .262E+02  .196E+01  .147E+01  .113E+04  .113E-01  .250E+01  .124E+02  .250E+01
 .243E+02  .940E+00  .13 E+01  .211E+02  .123E+01  .920E-00  .110E+04  .709E-02  .250E+01  .777E+01  .250E+01
 .274E+02  .910E+00  .154E+01  .169E+02  .760E-00  .570E-00  .111E+04  .429E-02  .250E+01  .474E+01  .250E+01
 .305E+02  .880E+00  .178E+01  .138E+02  .481E-00  .361E-00  .114E+04  .250E-02  .250E+01  .294E+01  .250E+01
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I. RHO-U PRINTOUT

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     W          COST        RMIN
 .100E+01    .000E+00    .200E-00

VAL=  .500E+01
  ALT          W           PART        Q           USP         DYNP        PARVEL      DENSTY      DENRAT       RHOU        OTHER
 .000E+00    .100E+01    .343E+01    .270E+01    .114E+01    .334E-01    .819E+02    .808E-01    .106E+01    .500E+01    .500E+01
 .305E+01    .100E+01    .303E+01    .333E+01    .113E+01    .442E-01    .670E+02    .609E-01    .108E+01    .500E+01    .500E+01
 .610E+01    .100E+01    .269E+01    .406E+01    .107E+01    .595E-01    .111E+03    .453E-01    .111E+01    .500E+01    .500E+01
 .914E+01    .100E+01    .242E+01    .472E+01    .101E+01    .814E-01    .151E+03    .333E-01    .114E+01    .501E+01    .501E+01
 .122E+02    .100E+01    .213E+01    .613E+01    .962E+00    .115E+00    .213E+03    .238E-01    .124E+01    .500E+01    .500E+01
 .152E+02    .100E+01    .198E+01    .782E+01    .929E+00    .165E+00    .311E+03    .160E-01    .134E+01    .500E+01    .500E+01
 .182E+02    .100E+01    .183E+01    .965E+01    .900E+00    .238E+00    .443E+03    .113E-01    .154E+01    .499E+01    .499E+01
 .213E+02    .970E+00    .170E+01    .120E+02    .852E+00    .334E+00    .619E+03    .809E-02    .178E+01    .500E+01    .500E+01
 .243E+02    .940E+00    .160E+01    .145E+02    .816E+00    .451E+00    .837E+03    .597E-02    .211E+01    .499E+01    .499E+01
 .274E+02    .910E+00    .151E+01    .178E+02    .779E+00    .621E+00    .115E+04    .434E-02    .255E+01    .500E+01    .500E+01
 .305E+02    .880E+00    .140E+01    .219E+02    .807E+00    .844E+00    .154E+04    .320E-02    .309E+01    .500E+01    .500E+01

VAL=  .100E+02
  ALT          W           PART        Q           USP         DYNP        PARVEL      DENSTY      DENRAT       RHOU        OTHER
 .000E+00    .100E+01    .204E+01    .724E+01    .231E+01    .127E+00    .114E+03    .849E-01    .111E+01    .100E+02    .100E+02
 .305E+01    .100E+01    .191E+01    .861E+01    .220E+01    .166E+00    .153E+03    .650E-01    .115E+01    .100E+02    .100E+02
 .610E+01    .100E+01    .175E+01    .947E+01    .205E+01    .216E+00    .202E+03    .494E-01    .121E+01    .956E+01    .998E+01
 .914E+01    .100E+01    .163E+01    .106E+02    .194E+01    .290E+00    .264E+03    .372E-01    .130E+01    .100E+02    .100E+02
 .122E+02    .100E+01    .152E+01    .128E+02    .182E+01    .378E+00    .356E+03    .271E-01    .144E+01    .100E+02    .100E+02
 .152E+02    .100E+01    .140E+01    .155E+02    .174E+01    .557E+00    .517E+03    .193E-01    .164E+01    .999E+01    .999E+01
 .182E+02    .100E+01    .134E+01    .179E+02    .167E+01    .767E+00    .710E+03    .141E-01    .192E+01    .100E+02    .100E+02
 .213E+02    .970E+00    .126E+01    .216E+02    .160E+01    .104E+01    .961E+03    .104E-01    .229E+01    .999E+01    .999E+01
 .243E+02    .940E+00    .119E+01    .263E+02    .156E+01    .130E+01    .125E+04    .783E-02    .277E+01    .100E+02    .100E+02
 .274E+02    .910E+00    .110E+01    .329E+02    .159E+01    .184E+01    .175E+04    .574E-02    .337E+01    .999E+01    .999E+01
 .305E+02    .880E+00    .104E+01    .396E+02    .172E+01    .260E+01    .241E+04    .419E-02    .402E+01    .100E+02    .100E+02

VAL=  .150E+02
  ALT          W           PART        Q           USP         DYNP        PARVEL      DENSTY      DENRAT       RHOU        OTHER
 .000E+00    .100E+01    .143E+01    .119E+02    .347E+01    .274E+00    .180E+03    .848E-01    .118E+01    .150E+02    .150E+02
 .305E+01    .100E+01    .150E+01    .135E+02    .323E+01    .352E+00    .214E+03    .659E-01    .122E+01    .150E+02    .150E+02
 .610E+01    .100E+01    .145E+01    .149E+02    .296E+01    .457E+00    .283E+03    .531E-01    .130E+01    .150E+02    .150E+02
 .914E+01    .100E+01    .136E+01    .167E+02    .249E+01    .594E+00    .368E+03    .400E-01    .142E+01    .150E+02    .150E+02
 .122E+02    .100E+01    .124E+01    .191E+02    .243E+01    .798E+00    .493E+03    .303E-01    .141E+01    .150E+02    .150E+02
 .152E+02    .100E+01    .117E+01    .224E+02    .252E+01    .110E+01    .676E+03    .221E-01    .187E+01    .150E+02    .150E+02
 .182E+02    .100E+01    .112E+01    .254E+02    .247E+01    .149E+01    .917E+03    .164E-01    .223E+01    .150E+02    .150E+02
 .213E+02    .970E+00    .106E+01    .305E+02    .235E+01    .159E+01    .123E+04    .122E-01    .269E+01    .150E+02    .150E+02
 .243E+02    .940E+00    .992E+00    .379E+02    .234E+01    .256E+01    .162E+04    .920E-02    .325E+01    .150E+02    .150E+02
 .274E+02    .910E+00    .926E+00    .457 +02    .244E+01    .364E+01    .225E+04    .657E-02    .392E+01    .150E+02    .150E+02
 .305E+02    .880E+00    .888E+00    .600E+02    .285E+01    .511E+01    .316E+04    .474E-02    .459E+01    .150E+02    .150E+02

VAL=  .200E+02
  ALT          W           PART        Q           USP         DYNP        PARVEL      DENSTY      DENRAT       RHOU        OTHER
 .000E+00    .100E+01    .137E+01    .164E+02    .448E+01    .457E+00    .216E+03    .925E-01    .121E+01    .200E+02    .200E+02
 .305E+01    .100E+01    .124E+01    .187E+02    .423E+01    .596E+00    .276E+03    .724E-01    .125E+01    .200E+02    .200E+02
 .610E+01    .100E+01    .120E+01    .205E+02    .395E+01    .781E+00    .353E+03    .565E-01    .136E+01    .200E+02    .200E+02
 .914E+01    .100E+01    .114E+01    .210E+02    .366E+01    .974E+00    .454E+03    .440E-01    .153E+01    .200E+02    .200E+02
 .122E+02    .100E+01    .100E+01    .251E+02    .342E+01    .130E+01    .601E+03    .333E-01    .174E+01    .200E+02    .200E+02
 .152E+02    .100E+01    .103E+01    .280E+02    .327E+01    .170E+01    .816E+03    .242E-01    .204E+01    .200E+02    .200E+02
 .182E+02    .100E+01    .990E+00    .323E+02    .314E+01    .236E+01    .103E+04    .163E-01    .249E+01    .200E+02    .200E+02
 .213E+02    .970E+00    .929E+00    .390E+02    .311E+01    .315E+01    .145E+04    .137E-01    .302E+01    .200E+02    .200E+02
 .243E+02    .940E+00    .870E+00    .437E+02    .328E+01    .439E+01    .194E+04    .103E-01    .363E+01    .200E+02    .200E+02
 .274E+02    .910E+00    .811E+00    .610E+02    .353E+01    .587E+01    .272E+04    .723E-02    .433E+01    .200E+02    .200E+02
 .305E+02    .880E+00    .734E+00    .797E+02    .426E+01    .843E+01    .391E+04    .512E-02    .494E+01    .200E+02    .200E+02

VAL=  .250E+02
  ALT          W           PART        Q           USP         DYNP        PARVEL      DENSTY      DENRAT       RHOU        OTHER
 .000E+00    .100E+01    .120E+01    .219E+02    .553E+01    .705E+00    .261E+03    .950E-01    .125E+01    .250E+02    .250E+02
 .305E+01    .100E+01    .112E+01    .238E+02    .520E+01    .889E+00    .330E+03    .759E-01    .134E+01    .250E+02    .250E+02
 .610E+01    .100E+01    .100E+01    .253E+02    .495E+01    .113E+01    .414E+03    .597E-01    .144E+01    .250E+02    .250E+02
 .914E+01    .100E+01    .102E+01    .269E+02    .449E+01    .143E+01    .532E+03    .470E-01    .164E+01    .250E+02    .250E+02
 .122E+02    .100E+01    .944E+00    .305E+02    .418E+01    .187E+01    .695E+03    .350E-01    .190E+01    .249E+02    .249E+02
 .152E+02    .100E+01    .939E+00    .3 6E+02    .401E+01    .253E+01    .934E+03    .264E-01    .229E+01    .250E+02    .250E+02
 .182E+02    .100E+01    .849E+00    .392E+02    .331E+01    .339E+01    .125E+04    .203 -01    .273E+01    .250E+02    .250E+02
 .213E+02    .970E+00    .841E+00    .467E+02    .331E+01    .451E+01    .167E+04    .150E-01    .330E+01    .250E+02    .250E+02
 .243E+02    .940E+00    .814E+00    .581E+02    .411E+01    .635E+01    .224E+04    .112E-01    .395E+01    .250E+02    .250E+02
 .274E+02    .910E+00    .723E+00    .747E+02    .471E+01    .855E+01    .317E+04    .787E-02    .443E+01    .250E+02    .250E+02
 .305E+02    .880E+00    .660E+00    .102E+03    .534E+01    .125E+02    .444E+04    .530E-02    .521E+01    .250E+02    .250E+02

VAL=  .300E+02
  ALT          W           PART        Q           USP         DYNP        PARVEL      DENSTY      DENRAT       RHOU        OTHER
 .000E+00    .100E+01    .104E+01    .267E+02    .655E+01    .976E+00    .302E+03    .994E-01    .130E+01    .300E+02    .300E+02
 .305E+01    .100E+01    .103E+01    .296E+02    .615E+01    .123E+01    .374E+03    .791E-01    .140E+01    .300E+02    .300E+02
 .610E+01    .100E+01    .944E+00    .204E+02    .572E+01    .154E+01    .477E+03    .624E-01    .154E+01    .300E+02    .300E+02
 .914E+01    .100E+01    .943E+00    .519E+02    .524E+01    .165E+01    .602E+03    .493E-01    .174E+01    .300E+02    .300E+02
 .122E+02    .100E+01    .934E+00    .356E+02    .493E+01    .253E+01    .782E+03    .393E-01    .203E+01    .300E+02    .300E+02
 .152E+02    .100E+01    .870E+00    .403E+02    .476E+01    .339E+01    .105E+04    .295E-01    .243E+01    .300E+02    .300E+02
 .182E+02    .100E+01    .820E+00    .462E+02    .467E+01    .431E+01    .133E+04    .213E-01    .293E+01    .300E+02    .300E+02
 .213E+02    .970E+00    .744E+00    .544E+02    .475E+01    .605E+01    .137E+04    .161E-01    .355E+01    .300E+02    .300E+02
 .243E+02    .940E+00    .712E+00    .605E+02    .519E+01    .814E+01    .252E+04    .119E-01    .420E+01    .300E+02    .300E+02
 .274E+02    .910E+00    .652E+00    .918E+02    .608E+01    .117E+02    .362E+04    .827E-02    .487E+01    .300E+02    .300E+02
 .305E+02    .880E+00    .543E+00    .129E+03    .797E+01    .175E+02    .539E+04    .555E-02    .538E+01    .300E+02    .300E+02
```

J. PRESSURE RATIO PROGRAM

```
FILE 5=MODSAX, UNIT = READER
      DIMENSION HOBKM(11),VAL(11)
    1 READ(5,2) W,COST,R,IM,IVAL
    2 FORMAT(3E10.3,2I2)
      READ(5,3) (HOBKM(I),I=1,IM)
    3 FORMAT(8E10.3)
       READ(5,3) (VAL(I),I=1,IVAL)
      CALL CLOSE(5,2HER)
      WRITE(6,4)
    4 FORMAT(30H      W       COST      RMIN  )
      WRITE(6,5) W,COST,R
    5 FORMAT(3E10.3)
      RMIN=R
      W1=W
      DO 50 I=1,IVAL
      WRITE(6,8) VAL(I)
    8 FORMAT(5H0VAL=,E10.3)
      WRITE(6,7)
    7 FORMAT(139H    ALT       W       RKFT       R        OVP      DT
     1MP      PARVEL    DENSITY   DENRAT        RHOU     OTHER  )
      OTHER=0.
      R=RMIN
       DO 50 J=1,IM
      KOUNT=0
      ALTCM=HOBKM(J)*1.E+5
         CALL ARDC(ALTCM,PRATIO,TRATIO,DRATIO)
      PSICTR=PRATIO*14.696
      PCR=PRATIO*1.01325E+6
      W=W1
C     THIS IS THE SCALING FACTOR FOR 1KT.
      SCAFAC=.37-(.04/9.144)*HOBKM(J)
      IF(HOBKM(J).GT.9.144)SCAFAC=.33+(.04/5.188)*(HOBKM(J)-9.144)
      IF(HOBKM(J).GT.18.22)SCAFAC=.37+(.13/12.19)*(HOBKM(J)-16.22)
C     REMOVE THE NEXT CARD IF INTERPOLATING FOR THERMAL ENERGY
      IF(HOBKM(J).GT.18.222)W=W1*(1.-.12*(HOBKM(J)-18.222)/12.222)
      IF(COST) 8,26,8
    8 ALT=HOBKM(J)+R*COST
C     COST=COSINE THETA=-1. FOR DOWNWARD.
      IF(ALT.GE.0.) GO TO 12
        ALT=0.
        R=-HOBKM(J)/COST
   12 ALTCM=ALT*1.E5
         CALL ARDC(ALTCM,PRATIO,TRATIO,DRATIO)
   26 PFACT=1./PRATIO
   13 RFACT=(W*PFACT)**.33333333
      RIKT=R/RFACT
         CALL RP1271(RIKT,P1KT)
      OVP=P1KT/PFACT
      PSIAMB=PRATIO*14.696
      POVPA=OVP/PSIAMB
   16 IF(KOUNT) 17,17,20
   17 P1=POVPA
      R1=R
      R=2.*R
      KOUNT=1
      GO TO 8
   20 P2=POVPA
      R2=R

      AN=R1/R2
      BN=P1/P2
      CN=VAL(I)/P1
      A=ALOG(AN)
      B=ALOG(BN)
      C=ALOG(CN)
      ACB=A*C/B
      R=R1*EXP(ACB)
      P1=P2
      R1=R2
      IF(ABS(R-R2)-.0010*R2) 14,14,21
   21 KOUNT=KOUNT+1
      IF(KOUNT-20) 8,8,22
   22 WRITE(6,23)
   23 FORMAT(20H0FAILED TO CONVERGE.)
      GO TO 50
   14 RKFT=R/.3048
      DENSTY=0.0764739*DRATIO*(7.0+6.0*POVPA)/(7.0+POVPA)
      DTMP=2.5*OVP*OVP/(7.*PSIAMB+OVP)
      Q=(7.96*W1*SCAFAC)/(R*R)
      DENRAT=(7.0+6.0*POVPA)/(7.0+POVPA)
      PARVEL=.7142857*POVPA*1116.215*SQRT(TRATIO/(7.0+0.857143*POVPA))
      RHOU=PARVEL*DENSTY
      OTHER=Q
      WRITE(6,15) ALT,W,RKFT,R,OVP,DTMP,PARVEL,DENSTY,DENRAT,RHOU,OTHER
   15 FORMAT (1H ,11E10.3)
   50 CONTINUE
      STOP
      END

01/19/72      4:04 PM      45M44.5      11073      COMPILER
  0 MIN 26 SEC FOR COMPILATION PASS
  93 CARDS AT 313 CARDS PER MINUTE
 1435 DIGITS DATA.   5344 DIGITS CODE.
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K. PRESSURE RATIO PRINTOUT

```
     b         COST      RMIN
  .100E+01  .080E+00  .200E+00

VAL= .570E+01
     ALT        W        RKFT        @         CVP       DYNP      PARVEL    DENSTY    DENRAT      RHOU      OTHER
  .000E+00  .100E+01  .308E-00  .335E+03  .838E+02  .848E+02  .187E+04  .248E-00  .324E+01  .465E+03  .570E+01
  .305E+01  .100E+01  .348E-00  .252E+03  .577E+02  .637E+02  .181E+04  .183E-00  .325E+01  .332E+03  .570E+01
  .610E+01  .100E+01  .398E-00  .125E+03  .384E+02  .433E+02  .174E+04  .132E-00  .325E+01  .231E+03  .571E+01
  .914E+01  .100E+01  .461E-00  .133E+03  .250E+02  .281E+02  .167E+04  .931E-01  .325E+01  .150E+03  .571E+01
  .122E+02  .100E+01  .538E-00  .101E+03  .154E+02  .175E+02  .162E+04  .613E-01  .324E+01  .934E+02  .570E+01
  .152E+02  .100E+01  .631E-00  .768E+02  .970E+01  .109E+02  .162E+04  .382E-01  .324E+01  .621E+02  .570E+01
  .182E+02  .100E+01  .738E-00  .580E+02  .604E+01  .678E+01  .162E+04  .238E-01  .324E+01  .387E+02  .570E+01
  .213E+02  .970E-00  .859E-00  .468E+02  .376E+01  .420E+01  .163E+04  .147E-01  .325E+01  .239E+02  .571E+01
  .243E+02  .940E-00  .994E-00  .377E+02  .234E+01  .262E+01  .163E+04  .918E-02  .325E+01  .150E+02  .571E+01
  .274E+02  .910E-00  .115E+01  .301E+02  .145E+01  .163E+01  .165E+04  .552E-02  .325E+01  .912E+01  .571E+01
  .305E+02  .880E-00  .133E+01  .243E+02  .915E-00  .103E+01  .169E+04  .336E-02  .325E+01  .565E+01  .571E+01

VAL= .240E+01
     ALT        W        RKFT        @         CVP       DYNP      PARVEL    DENSTY    DENRAT      RHOU      OTHER
  .000E+00  .100E+01  .458E-00  .158E+03  .353E+02  .225E+02  .109E+04  .174E-00  .228E+01  .181E+03  .240E+01
  .305E+01  .100E+01  .515E-00  .115E+03  .243E+02  .155E+02  .106E+04  .129E-00  .228E+01  .130E+03  .240E+01
  .610E+01  .100E+01  .589E-00  .849E+02  .162E+02  .104E+02  .102E+04  .928E-01  .228E+01  .944E+02  .240E+01
  .914E+01  .100E+01  .681E-00  .610E+02  .105E+02  .670E+01  .975E+03  .653E-01  .228E+01  .636E+02  .240E+01
  .122E+02  .100E+01  .794E-00  .434E+02  .655E+01  .418E+01  .943E+03  .430E-01  .228E+01  .408E+02  .240E+01
  .152E+02  .100E+01  .932E-00  .351E+02  .409E+01  .261E+01  .945E+03  .268E-01  .228E+01  .255E+02  .240E+01
  .182E+02  .100E+01  .109E+01  .260E+02  .256E+01  .162E+01  .948E+03  .167E-01  .228E+01  .159E+02  .240E+01
  .213E+02  .970E-00  .127E+01  .214E+02  .157E+01  .100E+01  .949E+03  .103E-01  .228E+01  .979E+01  .240E+01
  .243E+02  .940E-00  .147E+01  .173E+02  .982E-00  .627E-00  .949E+03  .645E-02  .228E+01  .612E+01  .240E+01
  .274E+02  .910E-00  .170E+01  .138E+02  .608E-00  .388E-00  .964E+03  .387E-02  .228E+01  .373E+01  .240E+01
  .305E+02  .880E-00  .196E+01  .111E+02  .385E-00  .246E-00  .983E+03  .235E-02  .228E+01  .231E+01  .240E+01

VAL= .130E+01
     ALT        W        RKFT        @         CVP       DYNP      PARVEL    DENSTY    DENRAT      RHOU      OTHER
  .000E+00  .100E+01  .608E-00  .859E+02  .191E+02  .748E+01  .713E+03  .134E-00  .178E+01  .873E+02  .130E+01
  .305E+01  .100E+01  .688E-00  .645E+02  .131E+02  .515E+01  .688E+03  .101E-00  .178E+01  .693E+02  .130E+01
  .610E+01  .100E+01  .787E-00  .475E+02  .879E+01  .348E+01  .662E+03  .727E-01  .178E+01  .483E+02  .130E+01
  .914E+01  .100E+01  .910E-00  .341E+02  .568E+01  .223E+01  .635E+03  .511E-01  .178E+01  .325E+02  .130E+01
  .122E+02  .100E+01  .106E+01  .259E+02  .355E+01  .139E+01  .616E+03  .337E-01  .178E+01  .208E+02  .130E+01
  .152E+02  .100E+01  .125E+01  .197E+02  .221E+01  .867E-00  .610E+03  .219E-01  .178E+01  .130E+02  .130E+01
  .182E+02  .100E+01  .148E+01  .152E+02  .138E+01  .540E-00  .618E+03  .131E-01  .178E+01  .808E+01  .130E+01
  .213E+02  .970E-00  .170E+01  .120E+02  .850E-00  .333E-00  .618E+03  .808E-02  .178E+01  .499E+01  .130E+01
  .243E+02  .940E-00  .198E+01  .965E+01  .532E-00  .208E-00  .619E+03  .505E-02  .178E+01  .312E+01  .130E+01
  .274E+02  .910E-00  .228E+01  .771E+01  .329E-00  .129E-00  .625E+03  .303E-02  .178E+01  .190E+01  .130E+01
  .305E+02  .880E-00  .263E+01  .623E+01  .208E-00  .816E-01  .641E+03  .186E-02  .178E+01  .118E+01  .130E+01

VAL= .660E-00
     ALT        W        RKFT        @         CVP       DYNP      PARVEL    DENSTY    DENRAT      RHOU      OTHER
  .000E+00  .100E+01  .871E-00  .518E+02  .970E+01  .202E+01  .421E+03  .109E-00  .143E+01  .460E+02  .660E-00
  .305E+01  .100E+01  .987E-00  .314E+02  .667E+01  .144E+01  .406E+03  .808E-01  .143E+01  .328E+02  .660E-00
  .610E+01  .100E+01  .113E+01  .231E+02  .446E+01  .941E-00  .391E+03  .578E-01  .143E+01  .228E+02  .660E-00
  .914E+01  .100E+01  .131E+01  .166E+02  .289E+01  .322E-00  .375E+03  .410E-01  .143E+01  .154E+02  .660E-00
  .122E+02  .100E+01  .153E+01  .126E+02  .189E+01  .388E-00  .365E+03  .271E-01  .143E+01  .987E+01  .660E-00
  .152E+02  .100E+01  .179E+01  .959E+01  .112E+01  .242E-00  .365E+03  .169E-01  .143E+01  .615E+01  .660E-00
  .182E+02  .100E+01  .203E+01  .723E+01  .700E-00  .151E-00  .365E+03  .105E-01  .143E+01  .383E+01  .660E-00
  .213E+02  .970E-00  .243E+01  .583E+01  .432E-00  .930E-01  .365E+03  .658E-02  .143E+01  .236E+01  .660E-00
  .243E+02  .940E-00  .282E+01  .470E+01  .270E-00  .581E-01  .365E+03  .405E-02  .143E+01  .148E+01  .660E-00
  .274E+02  .910E-00  .327E+01  .375E+01  .167E-00  .360E-01  .370E+03  .243E-02  .143E+01  .901E-00  .660E-00
  .305E+02  .880E-00  .376E+01  .305E+01  .106E-00  .228E-01  .378E+03  .146E-02  .143E+01  .559E-00  .660E-00

VAL= .660E-01
     ALT        W        RKFT        @         CVP       DYNP      PARVEL    DENSTY    DENRAT      RHOU      OTHER
  .000E+00  .100E+01  .399E+01  .200E+01  .970E-00  .227E-01  .512E+02  .801E-01  .105E+01  .410E+01  .660E-01
  .305E+01  .100E+01  .451E+01  .150E+01  .448E-00  .156E-01  .494E+02  .581E-01  .105E+01  .292E+01  .660E-01
  .610E+01  .100E+01  .510E+01  .110E+01  .646E-00  .104E-01  .475E+02  .427E-01  .105E+01  .203E+01  .660E-01
  .914E+01  .100E+01  .587E+01  .798E-00  .280E-00  .674E-02  .456E+02  .300E-01  .105E+01  .137E+01  .660E-01
  .122E+02  .100E+01  .698E+01  .603E-00  .180E-00  .421E-02  .444E+02  .198E-01  .105E+01  .879E-00  .660E-01
  .152E+02  .100E+01  .817E+01  .452E-00  .113E-00  .262E-02  .444E+02  .123E-01  .105E+01  .548E-00  .660E-01
  .182E+02  .100E+01  .957E+01  .348E-00  .700E-01  .163E-02  .444E+02  .769E-02  .105E+01  .341E-00  .660E-01
  .213E+02  .970E-00  .111E+02  .279E-00  .432E-01  .101E-02  .444E+02  .474E-02  .105E+01  .210E-00  .660E-01
  .243E+02  .940E-00  .129E+02  .224E-00  .270E-01  .630E-03  .444E+02  .296E-02  .105E+01  .132E-00  .660E-01
  .274E+02  .910E-00  .150E+02  .179E-00  .167E-01  .388E-03  .450E+02  .178E-02  .105E+01  .802E-01  .660E-01
  .305E+02  .880E-00  .172E+02  .145E-00  .106E-01  .247E-03  .460E+02  .108E-02  .105E+01  .497E-01  .657E-01

VAL= .400E-00
     ALT        W        RKFT        @         CVP       DYNP      PARVEL    DENSTY    DENRAT      RHOU      OTHER
  .000E+00  .100E+01  .118E+01  .238E+02  .588E+01  .796E-00  .275E+03  .972E-01  .127E+01  .368E+02  .400E-00
  .305E+01  .100E+01  .131E+01  .177E+02  .405E+01  .548E-00  .264E+03  .718E-01  .127E+01  .181E+02  .400E-00
  .610E+01  .100E+01  .150E+01  .130E+02  .271E+01  .366E-00  .253E+03  .518E-01  .127E+01  .133E+02  .400E-00
  .914E+01  .100E+01  .170E+01  .938E+01  .175E+01  .237E-00  .245E+03  .348E-01  .127E+01  .884E+01  .400E-00
  .122E+02  .100E+01  .203E+01  .713E+01  .109E+01  .148E-00  .239E+03  .240E-01  .127E+01  .570E+01  .400E-00
  .152E+02  .100E+01  .238E+01  .540E+01  .687E-00  .932E-01  .238E+03  .153E-01  .127E+01  .356E+01  .400E-00
  .182E+02  .100E+01  .278E+01  .408E+01  .424E-00  .574E-01  .239E+03  .912E-02  .127E+01  .223E+01  .400E-00
  .213E+02  .970E-00  .324E+01  .329E+01  .262E-00  .354E-01  .234E+03  .575E-02  .127E+01  .137E+01  .400E-00
  .243E+02  .940E-00  .375E+01  .265E+01  .164E-00  .222E-01  .238E+03  .360E-02  .127E+01  .859E-00  .400E-00
  .274E+02  .910E-00  .435E+01  .212E+01  .101E-00  .137E-01  .243E+03  .218E-02  .127E+01  .534E-00  .400E-00
  .305E+02  .880E-00  .501E+01  .171E+01  .642E-01  .868E-02  .248E+03  .131E-02  .127E+01  .325E-00  .400E-00
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L. SHOCK STRENGTH PRINTOUT

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      M          COST       RNIM
  .100E+01   .000E+00   .200E-00

VAL=  .670E+01
   ALT          M          RAFI         Q          DVP        DYNP       PARVEL     DENSTY     DENRAT       RHOU       OTHER
  .000E+00   .100E+01   .300E-00   .335E+03   .931E+02   .940E+02   .167E+04   .245E-00   .324E+01   .465E+03   .670E+01
  .305E+01   .100E+01   .340E-00   .252E+03   .576E+02   .646E+02   .181E+04   .181E-00   .324E+01   .331E+03   .670E+01
  .610E+01   .100E+01   .390E-00   .185E+03   .365E+02   .432E+02   .174E+04   .134E-00   .324E+01   .230E+03   .670E+01
  .914E+01   .100E+01   .461E-00   .133E+03   .244E+02   .200E+02   .167E+04   .939E-01   .324E+01   .155E+03   .671E+01
  .122E+02   .100E+01   .539E-00   .101E+03   .156E+02   .175E+02   .162E+04   .613E-01   .324E+01   .590E+02   .670E+01
  .152E+02   .100E+01   .631E-00   .748E+02   .970E+01   .109E+02   .162E+04   .380E-01   .324E+01   .621E+02   .670E+01
  .183E+02   .100E+01   .735E-00   .580E+02   .634E+01   .478E+01   .162E+04   .235E-01   .324E+01   .367E+02   .670E+01
  .213E+02   .970E+00   .859E-00   .446E+02   .373E+01   .418E+01   .162E+04   .147E-01   .324E+01   .238E+02   .670E+01
  .243E+02   .940E+00   .994E-00   .377E+02   .233E+01   .262E+01   .162E+04   .919E-02   .324E+01   .139E+02   .670E+01
  .274E+02   .910E+00   .115E+01   .301E+02   .144E+01   .162E+01   .165E+04   .551E-02   .324E+01   .910E+01   .670E+01
  .305E+02   .880E+00   .133E+01   .243E+02   .914E-00   .103E+01   .169E+04   .335E-02   .324E+01   .564E+01   .670E+01

VAL=  .340E+01
   ALT          M          RAFI         Q          DVP        DYNP       PARVEL     DENSTY     DENRAT       RHOU       OTHER
  .000E+00   .100E+01   .454E-00   .154E+03   .353E+02   .225E+02   .103E+04   .173E-00   .228E+01   .191E+03   .340E+01
  .305E+01   .100E+01   .515E-00   .115E+03   .242E+02   .155E+02   .104E+04   .127E-00   .228E+01   .130E+03   .340E+01
  .610E+01   .100E+01   .549E-00   .849E+02   .167E+02   .103E+02   .102E+04   .924E-01   .228E+01   .943E+02   .340E+01
  .914E+01   .100E+01   .641E-00   .610E+02   .115E+02   .655E+01   .973E+03   .652E-01   .228E+01   .636E+02   .340E+01
  .122E+02   .100E+01   .739E-00   .444E+02   .655E+01   .417E+01   .945E+03   .430E-01   .228E+01   .408E+02   .340E+01
  .152E+02   .100E+01   .834E-00   .351E+02   .410E+01   .260E+01   .944E+03   .264E-01   .228E+01   .254E+02   .340E+01
  .183E+02   .100E+01   .104E+01   .266E+02   .254E+01   .162E+01   .944E+03   .167E-01   .228E+01   .150E+02   .340E+01
  .213E+02   .970E+00   .127E+01   .214E+02   .157E+01   .100E+01   .943E+03   .104E-01   .228E+01   .977E+01   .340E+01
  .243E+02   .940E+00   .147E+01   .173E+02   .940E-00   .625E-00   .948E+03   .644E-02   .228E+01   .611E+01   .340E+01
  .274E+02   .910E+00   .176E+01   .138E+02   .607E-00   .367E-00   .963E+03   .387E-02   .228E+01   .374E+01   .340E+01
  .305E+02   .880E+00   .196E+01   .111E+02   .384E-00   .245E-00   .983E+03   .235E-02   .228E+01   .231E+01   .340E+01

VAL=  .230E+01
   ALT          M          RAFI         Q          DVP        DYNP       PARVEL     DENSTY     DENRAT       RHOU       OTHER
  .000E+00   .100E+01   .600E-00   .858E+02   .191E+02   .750E+01   .713E+03   .136E-00   .178E+01   .974E+02   .230E+01
  .305E+01   .100E+01   .690E-00   .645E+02   .131E+02   .515E+01   .683E+03   .101E-00   .178E+01   .693E+02   .230E+01
  .610E+01   .100E+01   .747E-00   .475E+02   .879E+01   .344E+01   .662E+03   .727E-01   .178E+01   .402E+02   .230E+01
  .914E+01   .100E+01   .910E-00   .341E+02   .560E+01   .223E+01   .635E+03   .511E-01   .178E+01   .325E+02   .230E+01
  .122E+02   .100E+01   .106E+01   .259E+02   .355E+01   .139E+01   .619E+03   .337E-01   .178E+01   .208E+02   .230E+01
  .152E+02   .100E+01   .123E+01   .197E+02   .221E+01   .866E-00   .614E+03   .214E-01   .178E+01   .130E+02   .230E+01
  .183E+02   .100E+01   .146E+01   .149E+02   .138E+01   .534E-00   .613E+03   .131E-01   .178E+01   .806E+01   .230E+01
  .213E+02   .970E+00   .175E+01   .120E+02   .850E-00   .333E-00   .616E+03   .808E-02   .178E+01   .499E+01   .230E+01
  .243E+02   .940E+00   .198E+01   .965E+01   .532E-00   .208E-00   .619E+03   .505E-02   .178E+01   .312E+01   .230E+01
  .274E+02   .910E+00   .226E+01   .771E+01   .324E-00   .129E-00   .624E+03   .303E-02   .178E+01   .190E+01   .230E+01
  .305E+02   .880E+00   .264E+01   .623E+01   .206E-00   .816E-01   .640E+03   .184E-02   .178E+01   .118E+01   .230E+01

VAL=  .146E+01
   ALT          M          RAFI         Q          DVP        DYNP       PARVEL     DENSTY     DENRAT       RHOU       OTHER
  .000E+00   .100E+01   .871E-00   .417E+02   .571E+01   .209E+01   .471E+03   .119E-00   .143E+01   .561E+02   .146E+01
  .305E+01   .100E+01   .967E-00   .314E+02   .397E+01   .144E+01   .405E+03   .808E-01   .143E+01   .376E+02   .146E+01
  .610E+01   .100E+01   .113E+01   .231E+02   .246E+01   .960E-00   .391E+03   .584E-01   .143E+01   .226E+02   .146E+01
  .914E+01   .100E+01   .131E+01   .166E+02   .159E+01   .621E-00   .373E+03   .419E-01   .143E+01   .154E+02   .146E+01
  .122E+02   .100E+01   .153E+01   .126E+02   .100E+01   .358E-00   .365E+03   .271E-01   .143E+01   .966E+01   .146E+01
  .152E+02   .100E+01   .179E+01   .950E+01   .112E+01   .242E-00   .345E+03   .169E-01   .143E+01   .615E+01   .146E+01
  .183E+02   .100E+01   .209E+01   .723E+01   .699E-00   .151E-00   .345E+03   .102E-01   .143E+01   .383E+01   .146E+01
  .213E+02   .970E+00   .243E+01   .583E+01   .432E-00   .930E-01   .345E+03   .640E-02   .143E+01   .235E+01   .146E+01
  .243E+02   .940E+00   .284E+01   .470E+01   .270E-00   .581E-01   .345E+03   .405E-02   .143E+01   .146E+01   .146E+01
  .274E+02   .910E+00   .327E+01   .375E+01   .167E-00   .360E-01   .370E+03   .243E-02   .143E+01   .900E-00   .146E+01
  .305E+02   .880E+00   .370E+01   .303E+01   .106E-00   .228E-01   .379E+03   .149E-02   .143E+01   .559E-00   .146E+01

VAL=  .107E+01
   ALT          M          RAFI         Q          DVP        DYNP       PARVEL     DENSTY     DENRAT       RHOU       OTHER
  .000E+00   .100E+01   .360E+01   .219E+01   .103E+01   .755E-01   .542E+02   .801E-01   .105E+01   .435E+01   .107E+01
  .305E+01   .100E+01   .431E+01   .164E+01   .732E-00   .175E-01   .523E+02   .593E-01   .105E+01   .310E+01   .107E+01
  .610E+01   .100E+01   .464E+01   .121E+01   .473E-00   .117E-01   .501E+02   .424E-01   .105E+01   .215E+01   .107E+01
  .914E+01   .100E+01   .576E+01   .871E-00   .306E-00   .757E-02   .481E+02   .301E-01   .105E+01   .145E+01   .107E+01
  .122E+02   .100E+01   .667E+01   .662E-00   .191E-00   .473E-02   .470E+02   .199E-01   .105E+01   .933E-00   .107E+01
  .152E+02   .100E+01   .740E+01   .501E-00   .119E-00   .295E-02   .470E+02   .124E-01   .105E+01   .581E-00   .107E+01
  .183E+02   .100E+01   .914E+01   .379E-00   .742E-01   .184E-02   .470E+02   .772E-02   .105E+01   .362E-00   .107E+01
  .213E+02   .970E+00   .106E+02   .306E-00   .450E-01   .113E-02   .470E+02   .473E-02   .105E+01   .223E-00   .107E+01
  .243E+02   .940E+00   .123E+02   .246E-00   .290E-01   .709E-03   .473E+02   .297E-02   .105E+01   .140E-00   .107E+01
  .274E+02   .910E+00   .143E+02   .197E-00   .177E-01   .434E-03   .477E+02   .179E-02   .105E+01   .852E-01   .107E+01
  .305E+02   .880E+00   .164E+02   .159E-00   .112E-01   .278E-03   .487E+02   .104E-02   .105E+01   .520E-01   .107E+01

VAL=  .140E+01
   ALT          M          RAFI         Q          DVP        DYNP       PARVEL     DENSTY     DENRAT       RHOU       OTHER
  .000E+00   .100E+01   .110E+01   .238E+02   .538E+01   .746E-00   .273E+03   .977E-01   .127E+01   .297E+02   .140E+01
  .305E+01   .100E+01   .131E+01   .177E+02   .404E+01   .546E-00   .265E+03   .719E-01   .127E+01   .191E+02   .140E+01
  .610E+01   .100E+01   .152E+01   .136E+02   .270E+01   .385E-00   .254E+03   .514E-01   .127E+01   .132E+02   .140E+01
  .914E+01   .100E+01   .176E+01   .938E+01   .175E+01   .238E-00   .245E+03   .344E-01   .127E+01   .843E+01   .140E+01
  .122E+02   .100E+01   .203E+01   .713E+01   .104E+01   .119E-00   .239E+03   .224E-01   .127E+01   .573E+01   .140E+01
  .152E+02   .100E+01   .238E+01   .546E+01   .691E-00   .920E-01   .234E+03   .154E-01   .127E+01   .357E+01   .140E+01
  .183E+02   .100E+01   .277E+01   .460E+01   .426E-00   .573E-01   .239E+03   .934E-02   .127E+01   .222E+01   .140E+01
  .213E+02   .970E+00   .324E+01   .379E+01   .262E-00   .354E-01   .237E+03   .573E-02   .127E+01   .137E+01   .140E+01
  .243E+02   .940E+00   .375E+01   .255E+01   .164E-00   .221E-01   .233E+03   .354E-02   .127E+01   .853E-00   .140E+01
  .274E+02   .910E+00   .433E+01   .212E+01   .101E-00   .137E-01   .242E+03   .215E-02   .127E+01   .523E-00   .140E+01
  .305E+02   .880E+00   .501E+01   .173E+01   .641E-01   .866E-02   .247E+03   .131E-02   .127E+01   .325E-00   .140E+01
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M. DENSITY PRINTOUT

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    W         COST       RMIN
 .100E+01   .000E+00   .200E-00

VAL=  .300E-00
   ALT         W         RKFI        Q          DYP        DYNP       PARVEL     DENSTY     DENRAT      RHOU       OTHER
 .000E+00   .100E+01   .250E-00   .509E+03   .145E+03   .211E+03   .255E+04   .302E-00   .392E+01   .766E+03   .300E-00
 .305E+01   .100E+01   .160E-00   .119E+04   .441E+03   .951E+03   .542E+04   .300E-00   .531E+01   .163E+04   .300E-00

FAILED TO CONVERGE.
 .914E+01   .100E+01   .000E+00   .119E+04   .000E+00   .000E+00   .000E+00   .287E-01   .100E+01   .000E+00   .287E-01
 .122E+02   .100E+01   .000E+00   .119E+04   .000E+00   .000E+00   .000E+00   .189E-01   .100E+01   .000E+00   .189E-01
 .152E+02   .100E+01   .000E+00   .119E+04   .000E+00   .000E+00   .000E+00   .114E-01   .100E+01   .000E+00   .114E-01
 .182E+02   .100E+01   .000E+00   .119E+04   .000E+00   .000E+00   .000E+00   .734E-02   .100E+01   .000E+00   .734E-02
 .213E+02   .970E-00   .000E+00   .119E+04   .000E+00   .000E+00   .000E+00   .453E-02   .100E+01   .000E+00   .453E-02
 .243E+02   .940E-00   .000E+00   .119E+04   .000E+00   .000E+00   .000E+00   .283E-02   .100E+01   .000E+00   .283E-02
 .274E+02   .910E-00   .000E+00   .119E+04   .000E+00   .000E+00   .000E+00   .170E-02   .100E+01   .000E+00   .170E-02
 .305E+02   .880E-00   .000E+00   .119E+04   .000E+00   .000E+00   .000E+00   .103E-02   .100E+01   .000E+00   .103E-02

VAL=  .200E-00
   ALT         W         RKFI        Q          DYP        DYNP       PARVEL     DENSTY     DENRAT      RHOU       OTHER
 .000E+00   .100E+01   .331E-00   .207E+03   .490E+02   .396E+02   .135E+04   .200E-00   .261E+01   .271E+03   .200E-00
 .305E+01   .100E+01   .314E-00   .313E+03   .732E+02   .930E+02   .207E+04   .200E-00   .354E+01   .415E+03   .200E-00
 .610E+01   .100E+01   .225E-00   .583E+03   .166E+03   .325E+03   .390E+04   .200E-00   .490E+01   .780E+03   .200E-00

FAILED TO CONVERGE.
 .122E+02   .100E+01   .000E+00   .533E+03   .000E+00   .000E+00   .000E+00   .189E-01   .100E+01   .000E+00   .189E-01
 .152E+02   .100E+01   .000E+00   .580E+03   .000E+00   .000E+00   .000E+00   .119E-01   .100E+01   .000E+00   .118E-01
 .182E+02   .100E+01   .000E+00   .580E+03   .000E+00   .000E+00   .000E+00   .734E-02   .100E+01   .000E+00   .734E-02
 .213E+02   .970E-00   .000E+00   .580E+03   .000E+00   .000E+00   .000E+00   .453E-02   .100E+01   .000E+00   .453E-02
 .243E+02   .940E-00   .000E+00   .580E+03   .000E+00   .000E+00   .000E+00   .283E-02   .100E+01   .000E+00   .283E-02
 .274E+02   .910E-00   .000E+00   .580E+03   .000E+00   .000E+00   .000E+00   .170E-02   .100E+01   .000E+00   .170E-02
 .305E+02   .880E-00   .000E+00   .580E+03   .000E+00   .000E+00   .000E+00   .103E-02   .100E+01   .000E+00   .103E-02

VAL=  .150E-00
   ALT         W         RKFI        Q          DYP        DYNP       PARVEL     DENSTY     DENRAT      RHOU       OTHER
 .000E+00   .100E+01   .539E-00   .109E+03   .245E+02   .185E+02   .852E+03   .150E-00   .191E+01   .126E+03   .150E-00
 .305E+01   .100E+01   .435E-00   .151E+03   .350E+02   .290E+02   .134E+04   .150E-00   .264E+01   .201E+03   .150E-00
 .610E+01   .100E+01   .345E-00   .248E+03   .545E+02   .730E+02   .212E+04   .150E-00   .368E+01   .319E+03   .150E-00
 .914E+01   .100E+01   .221E-00   .577E+03   .169E+03   .357E+03   .470E+04   .150E-00   .523E+01   .704E+03   .150E-00

FAILED TO CONVERGE.
 .152E+02   .100E+01   .000E+00   .577E+03   .000E+00   .000E+00   .000E+00   .118E-01   .100E+01   .000E+00   .118E-01
 .182E+02   .100E+01   .000E+00   .577E+03   .000E+00   .000E+00   .000E+00   .734E-02   .100E+01   .000E+00   .734E-02
 .213E+02   .970E-00   .000E+00   .577E+03   .000E+00   .000E+00   .000E+00   .453E-02   .100E+01   .000E+00   .453E-02
 .243E+02   .940E-00   .000E+00   .577E+03   .000E+00   .000E+00   .000E+00   .283E-02   .100E+01   .000E+00   .283E-02
 .274E+02   .910E-00   .000E+00   .577E+03   .000E+00   .000E+00   .000E+00   .170E-02   .100E+01   .000E+00   .170E-02
 .305E+02   .880E-00   .000E+00   .577E+03   .000E+00   .000E+00   .000E+00   .103E-02   .100E+01   .000E+00   .103E-02

VAL=  .100E-00
   ALT         W         RKFI        Q          DYP        DYNP       PARVEL     DENSTY     DENRAT      RHOU       OTHER
 .000E+00   .100E+01   .107E+01   .276E+02   .673E+01   .103E+01   .303E+03   .100E-00   .131E+01   .309E+02   .100E-00
 .305E+01   .100E+01   .695E-00   .633E+02   .124E+02   .494E+01   .677E+03   .999E-01   .177E+01   .476E+02   .999E-01
 .610E+01   .100E+01   .544E-00   .995E+02   .194E+02   .141E+02   .114E+04   .100E-00   .245E+01   .114E+03   .100E-00
 .914E+01   .100E+01   .421E-00   .155E+03   .304E+02   .378E+02   .187E+04   .100E-00   .349E+01   .187E+03   .100E-00
 .122E+02   .100E+01   .251E-00   .468E+03   .115E+03   .247E+03   .474E+04   .100E-00   .524E+01   .479E+03   .100E-00
 .152E+02   .100E+01   .000E+00   .468E+03   .000E+00   .000E+00   .000E+00   .115E-01   .100E+01   .000E+00   .114E-01
 .182E+02   .100E+01   .000E+00   .468E+03   .000E+00   .000E+00   .000E+00   .739E-02   .100E+01   .000E+00   .734E-02
 .213E+02   .970E-00   .000E+00   .468E+03   .000E+00   .000E+00   .000E+00   .453E-02   .100E+01   .000E+00   .453E-02

 .243E+02   .940E-00   .000E+00   .468E+03   .000E+00   .000E+00   .000E+00   .283E-02   .100E+01   .000E+00   .283E-02
 .274E+02   .910E-00   .000E+00   .468E+03   .000E+00   .000E+00   .000E+00   .170E-02   .100E+01   .000E+00   .170E-02
 .305E+02   .880E-00   .000E+00   .468E+03   .000E+00   .000E+00   .000E+00   .103E-02   .100E+01   .000E+00   .103E-02

VAL=  .950E-01
   ALT         W         RKFI        Q          DYP        DYNP       PARVEL     DENSTY     DENRAT      RHOU       OTHER
 .000E+00   .100E+01   .124E+01   .205E+02   .523E+01   .633E-00   .284E+03   .950E-01   .124E+01   .236E+02   .950E-01
 .305E+01   .100E+01   .746E-00   .549E+02   .114E+02   .379E+01   .608E+03   .950E-01   .164E+01   .578E+02   .950E-01
 .610E+01   .100E+01   .574E-00   .891E+02   .171E+02   .114E+02   .105E+04   .950E-01   .231E+01   .100E+03   .950E-01
 .914E+01   .100E+01   .450E-00   .140E+03   .254E+02   .304E+02   .173E+04   .951E-01   .332E+01   .164E+03   .951E-01
 .122E+02   .100E+01   .264E-00   .353E+03   .747E+02   .153E+03   .363E+04   .950E-01   .502E+01   .373E+03   .950E-01

FAILED TO CONVERGE.
 .182E+02   .100E+01   .000E+00   .353E+03   .000E+00   .000E+00   .000E+00   .734E-02   .100E+01   .000E+00   .734E-02
 .213E+02   .970E-00   .000E+00   .353E+03   .000E+00   .000E+00   .000E+00   .453E-02   .100E+01   .000E+00   .453E-02
 .243E+02   .940E-00   .000E+00   .353E+03   .000E+00   .000E+00   .000E+00   .283E-02   .100E+01   .000E+00   .283E-02
 .274E+02   .910E-00   .000E+00   .353E+03   .000E+00   .000E+00   .000E+00   .173E-02   .100E+01   .000E+00   .170E-02
 .305E+02   .880E-00   .000E+00   .353E+03   .000E+00   .000E+00   .000E+00   .103E-02   .100E+01   .000E+00   .103E-02

VAL=  .750E-01
   ALT         W         RKFI        Q          DYP        DYNP       PARVEL     DENSTY     DENRAT      RHOU       OTHER

FAILED TO CONVERGE.
 .305E+01   .100E+01   .117E+01   .225E+02   .596E+01   .951E-00   .317E+03   .750E-01   .133E+01   .237E+02   .750E-01
 .610E+01   .100E+01   .750E-00   .514E+02   .994E+01   .400E+01   .703E+03   .750E-01   .184E+01   .527E+02   .750E-01
 .914E+01   .100E+01   .546E-00   .874E+02   .146E+02   .115E+02   .121E+04   .750E-01   .262E+01   .907E+02   .750E-01
 .122E+02   .100E+01   .431E-00   .159E+03   .275E+02   .414E+02   .226E+04   .750E-01   .307E+01   .170E+03   .750E-01

FAILED TO CONVERGE.
 .182E+02   .100E+01   .000E+00   .159E+03   .000E+00   .000E+00   .000E+00   .734E-02   .100E+01   .000E+00   .734E-02
 .213E+02   .970E-00   .000E+00   .159E+03   .000E+00   .000E+00   .000E+00   .453E-02   .100E+01   .000E+00   .453E-02
 .243E+02   .940E-00   .000E+00   .159E+03   .000E+00   .000E+00   .000E+00   .283E-02   .100E+01   .000E+00   .283E-02
 .274E+02   .910E-00   .000E+00   .159E+03   .000E+00   .000E+00   .000E+00   .170E-02   .100E+01   .000E+00   .170E-02
 .305E+02   .880E-00   .000E+00   .159E+03   .000E+00   .000E+00   .000E+00   .103E-02   .100E+01   .000E+00   .103E-02
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N. THERMAL FLUX PROGRAM

THERMAL FLUX PROGRAM

```
FILE 5=HUDSAX, UNIT = READER                                            C
      DIMENSION HOBKM(11),VAL(11)                                       C
    1 READ(5,2) W,COST,R,IN,IVAL                                        C
    2 FORMAT(3E10.3,2I2)                                                C
      READ(5,3) (HOBKM(I),I=1,IN)                                       C
    3 FORMAT(8E10.3)                                                    C
      READ(5,3) (VAL(I),I=1,IVAL)                                       C
      CALL CLOSE(5,2HFR)                                                C
      WRITE(6,4)                                                        C
    4 FORMAT(30H     W       COST      RMIN    )                        C
      WRITE(6,5) W,COST,R                                               C
    5 FORMAT(3E10.3)                                                    C
      RMIN=R                                                            C
      W1=W                                                              C
      DO 50 I=1,IVAL                                                    C
      WRITE(6,9) VAL(I)                                                 C
    9 FORMAT(5H0VAL=,E10.3)                                             C
      WRITE(6,7)                                                        C
    7 FORMAT(109H    ALT      W       RKFT      Q       DVP      DY     C
     1NP      PARVEL     DENSTY    DENRAT      RHOU     OTHER  )        C
      OTHER=0.                                                          C
      R=RMIN                                                            C
      DO 50 J=1,IN                                                      C
      KOUNT=0                                                           C
      ALTCM=HOBKM(J)*1.E+5                                              C
         CALL ARDC(ALTCM,PRATIO,TRATIO,DRATIO)                          C
      PSICT=PRATIO*14.696                                               C
      PC=PRATIO*1.01325E+6                                              C
      W=W1                                                              C
C     THIS IS THE SCALING FACTOR FOR 1KT.                               C
      SCAFAC=.37-(.04/9.144)*HOBKM(J)                                   C
      IF(HOBKM(J).GT.9.144)SCAFAC=.33+(.04/9.144)*(HOBKM(J)-9.144)      C
      IF(HOBKM(J).GT.18.22)SCAFAC=.37+(.13/12.19)*(HOBKM(J)-18.22)      C
C     REMOVE THE NEXT CARD IF INTERPOLATING FOR THERMAL ENERGY          C
      IF(COST) 8,24,8                                                   C
    8 ALT=HOBKM(J)+R*COST                                               C
C     COST=COSINE THETA=-1. FOR DOWNWARD.                               C
      IF(ALT.GE.0.) GO TO 12                                            C
        ALT=0.                                                          C
        R=-HOBKM(J)/COST                                                C
   12 ALTCM=ALT*1.E+5                                                   C
         CALL ARDC(ALTCM,PRATIO,TRATIO,DRATIO)                          C
   24 PFACT=1./PRATIO                                                   C
   13 RFACT=(W*PFACT)**.33333333                                        C
      R1KT=R/RFACT                                                      C
         CALL HP1271(R1KT,P1KT)                                         C
      DVP=P1KT/PFACT                                                    C
      PSIAMB=PRATIO*14.696                                              C
      PDVPA=DVP/PSIAMB                                                  C
      DENSTY=0.076475*DRATIO*(7.0+6.0*PDVPA)/(7.0+PDVPA)                C
      Q=(7.96*W*SCAFAC)/(R*R)                                           C
   16 IF(KOUNT) 17,17,20                                                C
   17 P1=Q                                                              C
      R1=R                                                              C
      R=2.*R                                                            C
      KOUNT=1                                                           C
      GO TO 8                                                           C
   20 P2=Q                                                              C

      R2=R                                                              C
      AN=R1/R2                                                          C
      BN=P1/P2                                                          C
      CN=VAL(I)/P1                                                      C
      A=ALOG(AN)                                                        C
      B=ALOG(BN)                                                        C
      C=ALOG(CN)                                                        C
      ACB=A*C/B                                                         C
      R=R1*EXP(ACB)                                                     C
      P1=P2                                                             C
      R1=R2                                                             C
      IF(ABS(R-R2)-.0010*R2) 14,14,21                                   C
   21 KOUNT=KOUNT+1                                                     C
      IF(KOUNT-20) 8,8,22                                               C
   22 WRITE(6,23)                                                       C
   23 FORMAT(20H0FAILED TO CONVERGE.)                                   C
      GO TO 50                                                          C
   14 RKFT=R/.3048                                                      C
      DYNP=2.5*DVP*DVP/(7.0*PSIAMB+DVP)                                 C
      DENRAT=(7.0+6.0*PDVPA)/(7.0+PDVPA)                                C
      PARVEL=.714285*PDVPA*1116.235*SQRT(TRATIO/(1.0+0.85714*PDVPA))    C
      RHOU=PARVEL*DENSTY                                                C
      OTHER=P2                                                          C
      WRITE(6,15) ALT,W,RKFT,Q,DVP,DYNP,PARVEL,DENSTY,DENRAT,RHOU,OTHER C
   15 FORMAT (1H ,11E10.3)                                              C
   50 CONTINUE                                                          C
      STOP                                                              C
      END                                                               C

01/31/72    12:33 PM   ASMR4.5    13172     COMPILER
  0 MIN 59 SEC FOR COMPILATION PASS
   93 CARDS AT 091 CARDS PER MINUTE
  1582 DIGITS DATA,  5054 DIGITS CODE.
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O. THERMAL FLUX PRINTOUT

```
    M         COST       RMIN
 .100E+01  .000E+00   .200E+00

VAL=  .300E+02
  ALT        M          RKFI        Q          UVP        DYNP       PARVEL     DENSTY     DENRAT      RHOU       OTHER
 .000E+00  .100E+01  .103E+01  .300E+02  .722E+01  .118E+01  .329E+03  .104E+00  .133E+01  .334E+02  .300E+02
 .305E+01  .100E+01  .104E+01  .300E+02  .636E+01  .132E+01  .391E+03  .790E-01  .141E+01  .312E+02  .300E+02
 .610E+01  .100E+01  .990E+00  .300E+02  .545E+01  .151E+01  .473E+03  .626E-01  .153E+01  .290E+02  .300E+02
 .914E+01  .100E+01  .971E+00  .300E+02  .447E+01  .178E+01  .575E+03  .487E-01  .170E+01  .280E+02  .300E+02
 .122E+02  .100E+01  .990E+00  .300E+02  .411E+01  .192E+01  .689E+03  .357E-01  .189E+01  .245E+02  .300E+02
 .152E+02  .100E+01  .101E+01  .300E+02  .345E+01  .194E+01  .847E+03  .259E-01  .217E+01  .212E+02  .300E+02
 .182E+02  .100E+01  .103E+01  .300E+02  .291E+01  .205E+01  .104E+04  .177E-01  .241E+01  .163E+02  .300E+02
 .213E+02  .100E+01  .107E+01  .300E+02  .233E+01  .196E+01  .122E+04  .124E-01  .269E+01  .149E+02  .300E+02
 .243E+02  .100E+01  .111E+01  .300E+02  .186E+01  .187E+01  .143E+04  .882E-02  .298E+01  .121E+02  .300E+02
 .274E+02  .100E+01  .116E+01  .300E+02  .155E+01  .180E+01  .172E+04  .560E-02  .333E+01  .971E+01  .300E+02
 .305E+02  .100E+01  .120E+01  .300E+02  .131E+01  .176E+01  .207E+04  .361E-02  .369E+01  .766E+01  .300E+02

VAL=  .250E+02
  ALT        M          RKFI        Q          UVP        DYNP       PARVEL     DENSTY     DENRAT      RHOU       OTHER
 .000E+00  .100E+01  .113E+01  .250E+02  .615E+01  .876E+00  .288E+03  .982E-01  .124E+01  .282E+02  .250E+02
 .305E+01  .100E+01  .111E+01  .250E+02  .542E+01  .959E+00  .341E+03  .756E-01  .135E+01  .261E+02  .250E+02
 .610E+01  .100E+01  .108E+01  .250E+02  .479E+01  .110E+01  .414E+03  .596E-01  .146E+01  .247E+02  .250E+02
 .914E+01  .100E+01  .108E+01  .250E+02  .426E+01  .126E+01  .505E+03  .459E-01  .160E+01  .232E+02  .250E+02
 .122E+02  .100E+01  .108E+01  .250E+02  .341E+01  .129E+01  .600E+03  .332E-01  .176E+01  .199E+02  .250E+02
 .152E+02  .100E+01  .111E+01  .250E+02  .284E+01  .137E+01  .750E+03  .231E-01  .195E+01  .171E+02  .250E+02
 .182E+02  .100E+01  .114E+01  .250E+02  .238E+01  .145E+01  .904E+03  .163E-01  .221E+01  .148E+02  .250E+02
 .213E+02  .100E+01  .118E+01  .250E+02  .191E+01  .140E+01  .108E+04  .112E-01  .247E+01  .120E+02  .250E+02
 .243E+02  .100E+01  .122E+01  .250E+02  .155E+01  .135E+01  .127E+04  .790E-02  .275E+01  .969E+01  .250E+02
 .274E+02  .100E+01  .127E+01  .250E+02  .125E+01  .129E+01  .151E+04  .521E-02  .307E+01  .750E+01  .250E+02
 .305E+02  .100E+01  .131E+01  .250E+02  .104E+01  .125E+01  .181E+04  .352E-02  .340E+01  .437E+01  .250E+02

VAL=  .200E+02
  ALT        M          RKFI        Q          UVP        DYNP       PARVEL     DENSTY     DENRAT      RHOU       OTHER
 .000E+00  .100E+01  .120E+01  .200E+02  .512E+01  .606E+00  .244E+03  .946E-01  .124E+01  .231E+02  .200E+02
 .305E+01  .100E+01  .124E+01  .200E+02  .449E+01  .670E+00  .291E+03  .734E-01  .130E+01  .213E+02  .200E+02
 .610E+01  .100E+01  .121E+01  .200E+02  .387E+01  .751E+00  .347E+03  .562E-01  .138E+01  .195E+02  .200E+02
 .914E+01  .100E+01  .119E+01  .200E+02  .331E+01  .856E+00  .423E+03  .434E-01  .150E+01  .185E+02  .200E+02
 .122E+02  .100E+01  .121E+01  .200E+02  .275E+01  .863E+00  .510E+03  .304E-01  .163E+01  .157E+02  .200E+02
 .152E+02  .100E+01  .124E+01  .200E+02  .225E+01  .897E+00  .627E+03  .212E-01  .180E+01  .133E+02  .200E+02
 .182E+02  .100E+01  .126E+01  .200E+02  .186E+01  .948E+00  .772E+03  .149E-01  .201E+01  .114E+02  .200E+02
 .213E+02  .100E+01  .131E+01  .200E+02  .145E+01  .914E+00  .916E+03  .101E-01  .223E+01  .924E+01  .200E+02
 .243E+02  .100E+01  .136E+01  .200E+02  .121E+01  .848E+00  .109E+04  .704E-02  .249E+01  .765E+01  .200E+02
 .274E+02  .100E+01  .142E+01  .200E+02  .981E+00  .874E+00  .131E+04  .473E-02  .278E+01  .419E+01  .200E+02
 .305E+02  .100E+01  .149E+01  .200E+02  .803E+00  .837E+00  .156E+04  .319E-02  .309E+01  .347E+01  .200E+02

VAL=  .150E+02
  ALT        M          RKFI        Q          UVP        DYNP       PARVEL     DENSTY     DENRAT      RHOU       OTHER
 .000E+00  .100E+01  .145E+01  .150E+02  .406E+01  .395E+00  .194E+03  .910E-01  .119E+01  .170E+02  .150E+02
 .305E+01  .100E+01  .144E+01  .150E+02  .352E+01  .416E+00  .235E+03  .693E-01  .124E+01  .164E+02  .150E+02
 .610E+01  .100E+01  .146E+01  .150E+02  .305E+01  .463E+00  .284E+03  .531E-01  .130E+01  .151E+02  .150E+02
 .914E+01  .100E+01  .137E+01  .150E+02  .261E+01  .511E+00  .345E+03  .394E-01  .130E+01  .138E+02  .150E+02
 .122E+02  .100E+01  .140E+01  .150E+02  .211E+01  .522E+00  .414E+03  .283E-01  .150E+01  .117E+02  .150E+02
 .152E+02  .100E+01  .145E+01  .150E+02  .170E+01  .529E+00  .506E+03  .191E-01  .167E+01  .998E+01  .150E+02
 .182E+02  .100E+01  .145E+01  .150E+02  .139E+01  .549E+00  .623E+03  .131E-01  .179E+01  .818E+01  .150E+02
 .213E+02  .100E+01  .152E+01  .150E+02  .110E+01  .529E+00  .742E+03  .894E-02  .197E+01  .681E+01  .150E+02
 .243E+02  .100E+01  .156E+01  .150E+02  .842E+00  .519E+00  .883E+03  .617E-02  .219E+01  .543E+01  .150E+02
 .274E+02  .100E+01  .164E+01  .150E+02  .716E+00  .514E+00  .107E+04  .419E-02  .244E+01  .444E+01  .150E+02
 .305E+02  .100E+01  .169E+01  .150E+02  .546E+00  .503E+00  .129E+04  .281E-02  .272E+01  .343E+01  .150E+02

VAL=  .100E+02
  ALT        M          RKFI        Q          UVP        DYNP       PARVEL     DENSTY     DENRAT      RHOU       OTHER
 .000E+00  .100E+01  .176E+01  .100E+02  .232E+01  .201E+00  .146E+03  .871E-01  .114E+01  .127E+02  .100E+02
 .305E+01  .100E+01  .173E+01  .100E+02  .257E+01  .225E+00  .177E+03  .664E-01  .114E+01  .119E+02  .100E+02
 .610E+01  .100E+01  .176E+01  .100E+02  .217E+01  .238E+00  .211E+03  .492E-01  .122E+01  .105E+02  .100E+02
 .914E+01  .100E+01  .170E+01  .100E+02  .145E+01  .253E+00  .257E+03  .344E-01  .127E+01  .848E+01  .100E+02
 .122E+02  .100E+01  .172E+01  .100E+02  .145E+01  .257E+00  .305E+03  .254E-01  .135E+01  .760E+01  .100E+02
 .152E+02  .100E+01  .175E+01  .100E+02  .117E+01  .267E+00  .377E+03  .171E-01  .145E+01  .643E+01  .100E+02
 .182E+02  .100E+01  .179E+01  .100E+02  .940E+00  .254E+00  .462E+03  .115E-01  .156E+01  .530E+01  .100E+02
 .213E+02  .100E+01  .190E+01  .100E+02  .724E+00  .246E+00  .567E+03  .741E-02  .166E+01  .417E+01  .100E+02
 .243E+02  .100E+01  .193E+01  .100E+02  .575E+00  .240E+00  .654E+03  .524E-02  .184E+01  .340E+01  .100E+02
 .274E+02  .100E+01  .210E+01  .100E+02  .461E+00  .238E+00  .794E+03  .345E-02  .201E+01  .276E+01  .100E+02
 .305E+02  .100E+01  .207E+01  .100E+02  .376E+00  .235E+00  .961E+03  .231E-02  .225E+01  .225E+01  .100E+02

VAL=  .500E+01
  ALT        M          RKFI        Q          UVP        DYNP       PARVEL     DENSTY     DENRAT      RHOU       OTHER
 .000E+00  .100E+01  .256E+01  .500E+01  .176E+01  .256E-01  .919E+02  .839E-01  .104E+01  .782E+01  .500E+01
 .305E+01  .100E+01  .247E+01  .500E+01  .151E+01  .788E-01  .109E+03  .624E-01  .110E+01  .673E+01  .500E+01
 .610E+01  .100E+01  .243E+01  .500E+01  .124E+01  .792E-01  .127E+03  .463E-01  .113E+01  .543E+01  .500E+01
 .914E+01  .100E+01  .219E+01  .500E+01  .107E+01  .934E-01  .154E+03  .315E-01  .117E+01  .525E+01  .500E+01
 .122E+02  .100E+01  .243E+01  .500E+01  .817E+00  .416E-01  .184E+03  .224E-01  .121E+01  .420E+01  .500E+01
 .152E+02  .100E+01  .247E+01  .500E+01  .617E+00  .809E-01  .225E+03  .169E-01  .125E+01  .333E+01  .500E+01
 .182E+02  .100E+01  .256E+01  .500E+01  .506E+00  .403E-01  .277E+03  .864E-02  .132E+01  .266E+01  .500E+01
 .213E+02  .100E+01  .264E+01  .500E+01  .378E+00  .719E-01  .329E+03  .624E-02  .138E+01  .204E+01  .500E+01
 .243E+02  .100E+01  .273E+01  .500E+01  .255E+00  .695E-01  .384E+03  .414E-02  .137E+01  .184E+01  .500E+01
 .274E+02  .100E+01  .283E+01  .500E+01  .216E+00  .630E-01  .474E+03  .254E-02  .157E+01  .104E+01  .500E+01
 .305E+02  .100E+01  .293E+01  .500E+01  .141E+00  .611E-01  .573E+03  .175E-02  .173E+01  .101E+01  .500E+01
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